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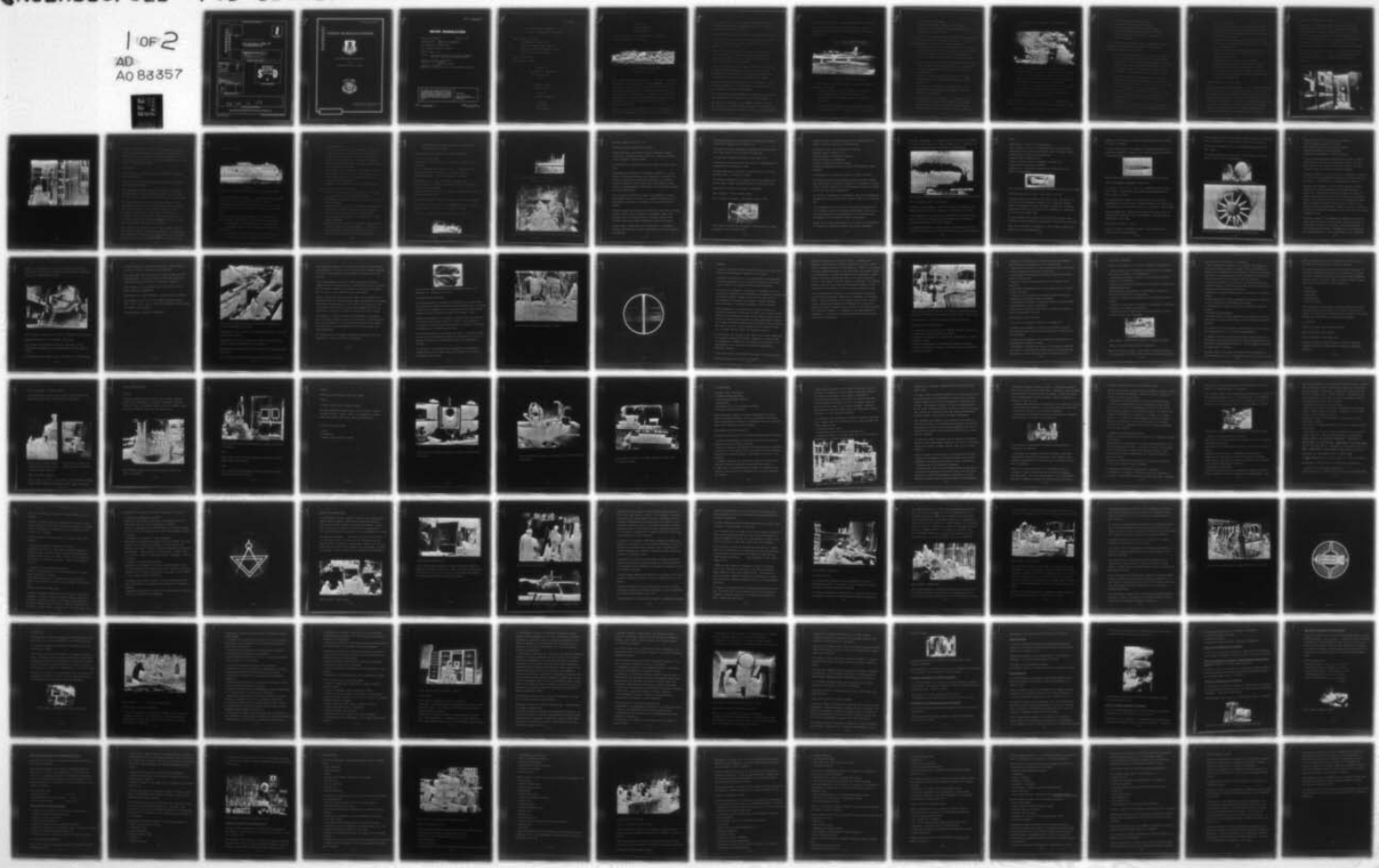

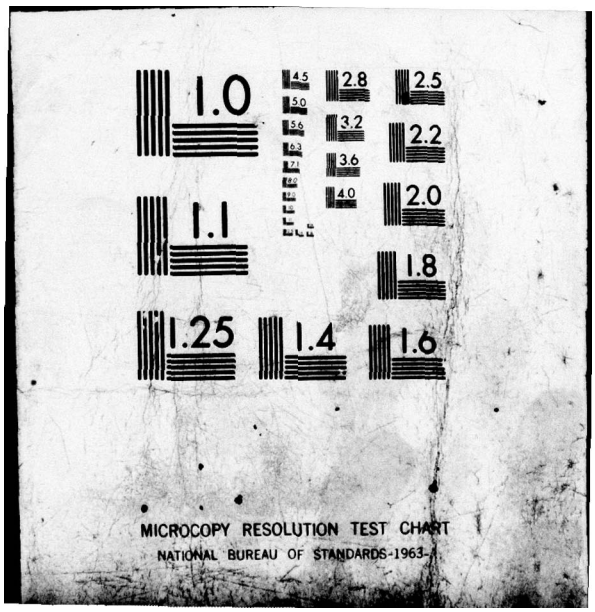
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FOREIGN TECHNOLOGY DIVISION

THE INSTITUTE OF AERONAUTICS

by

Gordana Velickovic, Editor

EDITED TRANSLATION

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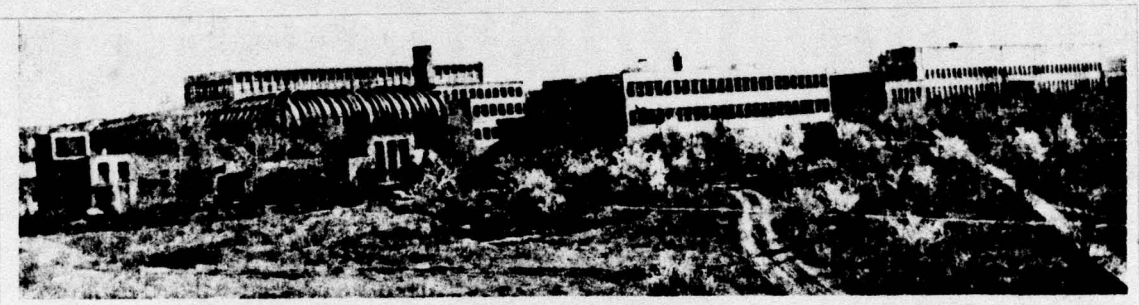


THE INSTITUTE OF AERONAUTICS

Belgrade - Zarkovo

The Institute of Aeronautics (VTI) is a scientific and research establishment founded in 1946. The VTI performs scientific-research, project, technical, documentation-information, and manufacturing services of the aeronautical activity, as well as other fields of technology. It possesses a large number of laboratories and testing installations with the most advanced equipment, and a scientific-professional library and standardization files.

About 60 aeronautical, mechanical, electric, technological, and chemical engineers, and a related number of technicians

of various fields, as well as highly skilled workers from various specialties are employed full time in scientific-research, and project activities.

The number of highly skilled cadres is constantly increasing.

A large number of scientific-research works published in the form of announcements, reports, and technical-economic analyses have been carried out so far.

The scientific-professional library has over 10,000 books and 3,100 volumes of foreign and domestic magazines with approximately 36,000 journals, and over 3,000 copies of professional-technical documentation.

From its beginnings and up to 1967, the VTI was a scientific-research military institution for the technical field of aeronautics, and from 1967 on it has been operating by the principles of acquisition and distribution of revenues.

During its entire existence, the VTI has accomplished a full material production, and has developed a cooperation with a large number of economic organizations.

The scientific-research projects are worked out in cooperation with the economy, for both military and civilian needs.

The great and successfully accomplished projects of the VTI are the airplane designs "Galeb," "Jastreb," and "Kraguj" that have received a high international acclaim, and they represent

a first-class engineering accomplishment in their categories.

In the past 25 years, the VTI has evolved into a strong scientific-research organization that performs the following operations:

(Caption) The "Galeb" on the Runway

1. In the field of aeronautical science and other branches of science and technology:

- planning, stimulating, and creating the conditions for the development of scientific activity and the advancement of the aeronautical and other technical research;

- developing and applying scientific research methods and solving the problems of interest to the aeronautics and

other fields of technology;

- organizing scientific groups and consultations, scientific and professional lectures, seminars, and sessions in its laboratories.

2. To secure both design and technical securities of construction, i.e. manufacture within the framework of technical research and standardization, it performs the following operations:

- monitors domestic, foreign, and international research and standardization, carries out the policy of standardization in the aeronautical science, and cooperates with the organs in charge of both military and civilian sectors;
- carries out technical research preceeding standardization, prepares materials or draws up plans for the regulations on technical measures, technical rules, standards, and specifications;
- performs the quality control of products and reports with the purpose of issuing (attestation, and quality seals);
- carries out certification of aircraft, spare parts, sub-assemblies, assemblies, manufactured equipment, devices, and machinery;
- also performs other operations in connection with the aeronautical and other terminologies, classification, nomenclature of material resources, normativeness, patents, seals, models, samples, licenses, as well as

the introduction and application of the International Units System;

- the VTI is authorized to carry out testing for air pollution during the operation of industrial installations (Yugoslav Official Gazette, No. 47/69), as well as the inspection of machinery and equipment in the machine and agricultural industries (Decree on amendments and supplements of the Decree on selecting the establishments that satisfy the requirements for issuance of the certificates in the field of workers' protection (The Serbia's Official Gazette, No. 48/70).

3. The Institute performs the operations of the engineering type, i.e. the project-design services from the following fields:

- shell-, truss-, and other metal construction,

- hydro- and pneumatic installations,
- transportation and navigation organs,
- devices for amortization and braking action,
- all kinds of measuring instruments and devices,
- repair workshops, and industrial projects for specific purposes.

4. In order to solve problems in the aeronautical and other branches of technology, the Institute carries out the following testing and measurements:

- in the field of aerodynamics, it carries out testing in its wind tunnels of all kinds of models, aircraft, and objects of other branches of technology (automobiles, trains, ships, fans, construction projects) by means of air currents ranging from the lowest speeds and up to the speeds three times higher than the speed of sound;

- performs the following measurements in the field of electronic measurements and testing of various physical and mechanical values in the electric and electronic way: static deformation, torsional oscillations, sound processes, short time intervals, acceleration, pressures, dynamic vibrations, temperature, fluid flow, force, lift, displacement, and other physical and mechanical quantities;
- performs testing of structures and complete electric devices and appliances in the field of electric and

electronic equipment;

- performs mechanical and climatic testing of equipment and materials for all the temperatures ranging from - 60° Celsius and up to plus 130° Celsius, according to all world standards;
- examines mechanical-technological characteristics of all kinds of metals and monmetals, structural elements, and finished products;
- performs analyses and determines the characteristics of all kinds of propulsion materials in the fuel and lubricant laboratory;
- processes wood and metals in its workshops;
- tests fireproof partitions exposed to the action of gaseous currents of high temperature (up to 1200° Celsius), for the Yugoslav shipbuilding. These tests are recognized by the Lloyd, Yugoslav Registry, USSR Registry, and Sudoimport.

Scientific-Technical Documentation

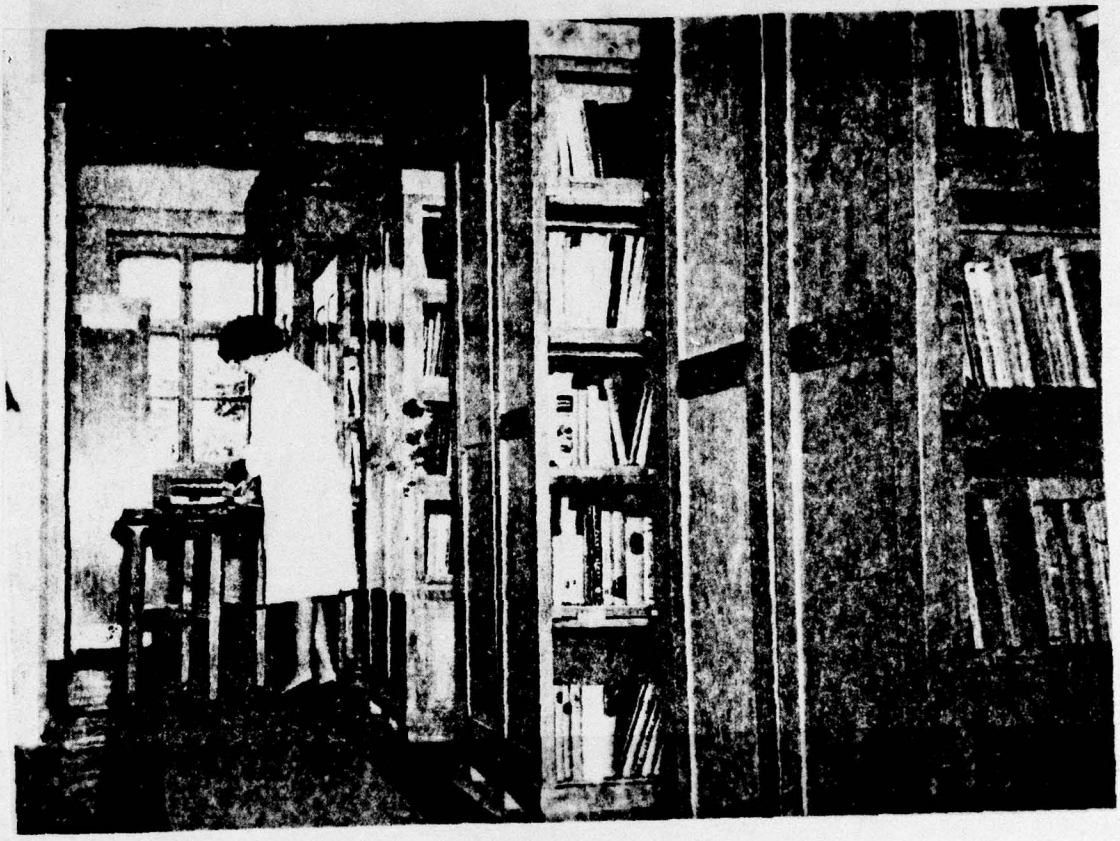
At the time of extensive development of the scientific-research work in the world, a well organized service of the scientific information and documentation has become an indispensable part of every serious research. Starting with this fact, The Institute of Aeronautics, since its very inception, has devoted a particular attention to its documentation and information services, whose jurisdiction is to gather information from various sources (domestic and foreign), and to provide

information of technical character.

The holdings of documents (books, periodical publications, regulations, standards, data bases, journals and pamphlets) of both domestic and foreign origin, contain much information of use also to non-aeronautical branches of technology, i.e. to scientific workers, which can be obtained either unprocessed (as copies), or assorted and processed according to the requests that can also be of a lasting character (subscription).

The Institute regularly subscribes to approximately 90 foreign and domestic magazines, so that by now it possesses about 3100 complete volumes, or approximately 36,000 copies of magazines.

The scientific-professional library contains over 10,000 books and over 3,000 professional-technical documentations.



To make various kinds of copies and recordings in connection with research and testing, this service is equipped with the necessary technical equipment that enables performing the reproduction, bookbinding, and photo services (black and white, color, and highspeed filming).

AERODYNAMICS

The scientific-research work in the "Aerodynamics" reflects great versatility.

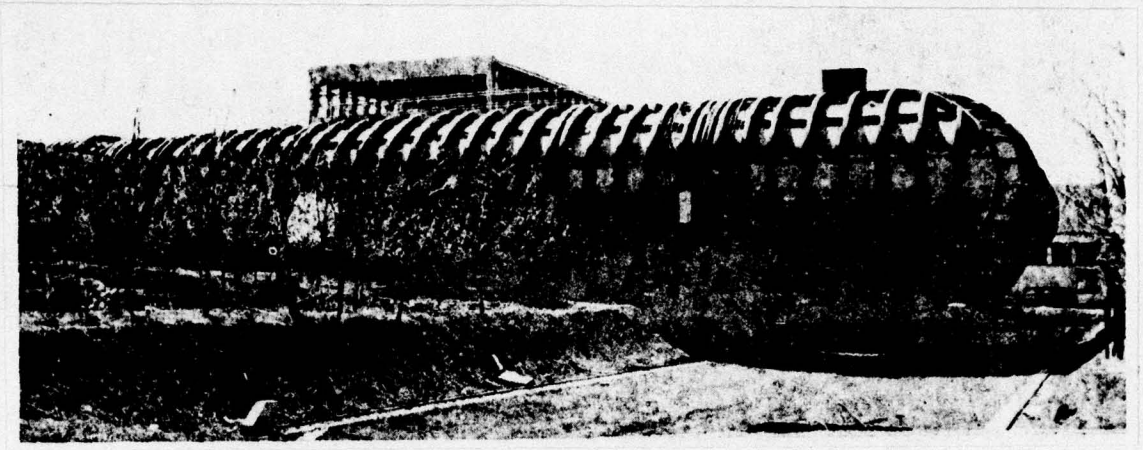
Research is carried out by using both theoretical-analytical and experimental methods.

The theoretical-analytical research is based on the results obtained through solving specific individual tasks, and they represent a starting point for further study and research works.

The development of aeronautical resources requires a large quantity of aerodynamic data that represent the starting point for a further study. For this reason, numerous advanced research and experimental installations and devices are installed in the VTI that enable testing various models and projects, starting with the lowest velocities, and up to those three times higher than the speed of sound.

The aerodynamic wind tunnels, at the VTI's disposal, enable experimental testing of aerodynamic phenomena in various models and projects for the benefit of various branches of technology. In the past period of time, this has included over 800 models for the military

and civilian needs.



(Photo)

Caption: View toward the large aerodynamic T-35 Wind Tunnel

The aerodynamic wind tunnels, as experimental installations, enable visual observations of phenomena, as well as measurements and recordings of the phenomena by means of the most advanced electronic instruments, devices, and measuring tapes.

The experimental data thus obtained are of a wide spectrum that comprise the following from the field of aerodynamics:

- determination of forces and moments acting upon the model (motorized, or not) at various positions (with or without lift),
- measurements of the moments of the hinges acting upon the movable surfaces, as well as the loads on the

protruding objects,

- recordings of the pressure distribution on the models' surfaces to determine local loads on the structure,
- recordings of the capacity of the air induction at various regimes of operation of the related group,
- testing the unhooking of the protruding objects (along with the dynamic similarity),
- determination of the effect of other objects, such as: soil, smoke, sand, snow, rain, and the like via the pictures showing paths of flow (streamlining) and accumulation (compression),
- testing characteristics of the fans and windmills.

From the field of the fluid dynamics:

- testing the hydrodynamic characteristics of the underwater objects, and the cavitation phenomena,
- experimental testing of pipelines or other systems of fluid conduction,
- experiments to find optimal solutions for ventilation or artificial acclimatisation for various purposes,
- research in connection with the control devices operating under the effect of relative air or other gaseous currents,
- examination of the effect of atmospheric agents on the partially sealed partitions (windows, and others),
- examination of fireproof partitions exposed to the effect of gaseous currents of high temperature,

- various testing connected with thermal requirements (temperature, and others).

THE AERODYNAMIC WIND TUNNEL T-31 WITH THE FREE JET

In operation since 1955.

The operating area is circular, 2.5 meters in diameter, with a free jet.

The main structure represents, in fact, a collector made of steel sheet metal 5 mm thick and reinforced with the stiffening elements. The total length is 10 meters.

Contraction 4; the filter is of the honeycomb shape.

The installed power: 600 KW, three-phase motor, asynchronous, with the voltage regulator.

The fan (propeller) 5 meters in diameter , six-bladed and made of a thin steel sheet metal.

The maximum velocity of the air current is 40 meters per second.

The maximum velocity with the added collector that reduces the jet to 1 meter in diameter, is 52 meters per second.

The factor of turbulence: 2.0 (by means of a sphere).

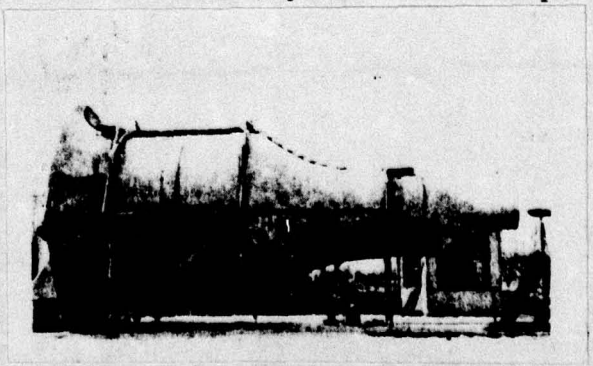


Photo Caption: The T-31 aerodynamic wind tunnel with the added collector

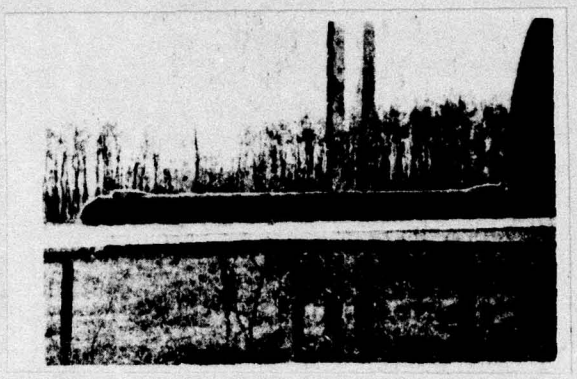


Photo Caption: Testing the aluminum train model in the T-31 aerodynamic wind tunnel

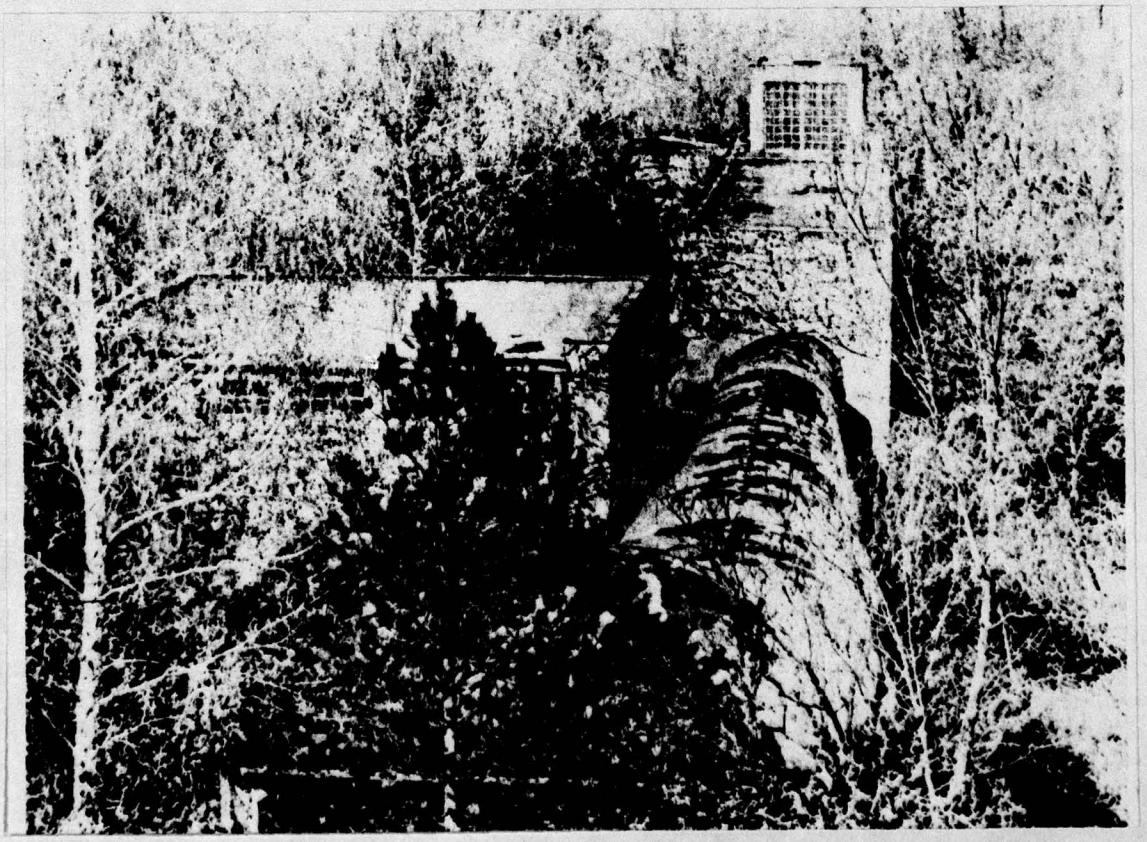


Photo Caption: View of the complex of the T-32 and T-33 aerodynamic wind tunnels

Reynolds number: 300,000 per dm.

Original pressure: atmospheric pressure.

Observations and visualizations of the phenomena of object rejection or combustion process which in a normal wind tunnel would represent a certain hazard.

The possibility of testing parts of the object in their actual size.

Although this wind tunnel was primarily intended - if a wind tunnel of larger dimensions is not available - to satisfy the needs of aeronautical requirements regarding the testing of aircraft elements in their actual size, there exists a whole series of non-aeronautical problems which can be usefully solved with minor adaptations.

Thus, besides calibrating all kinds of anemometers of larger dimensions, models of windmills or windmills themselves up to approximately two meters in diameter can also be effectively tested.

This wind tunnel is particularly suitable for that kind of testing whereby certain parts or products of processes (gases, toxic matters, etc.) are ejected from the elements, which in the standard wind tunnel always represents a problem or hazard.

Observations or measurements of deformations, or reduction of elements separating up to their destruction here do not represent any obstacle.

Aerodynamic testing for contamination of combustion products in apartment houses, decks of ships, etc.

Filling-in with sand, formation of snowdrifts, and protection from these elements can be studied and analyzed.

THE SMALL-SIZE SUBSONIC AERODYNAMIC WIND TUNNEL T-32

Planning and construction from 1948 to 1950. Calibrations and adaptations were completed in 1952.

The operating part is elliptical, measuring 1.8 x 1.2 meters, partially open, 2.0 meters in length.

The design is standard with 4 joints, with total length of 60 meters, made of wood, and protected with a thin sheet metal.

Contraction 5; filter in the shape of honeycomb.

Power capacity: 110 kW, Leonard group.

Fan 2.5 meters in diameter, four-bladed, made of wood.

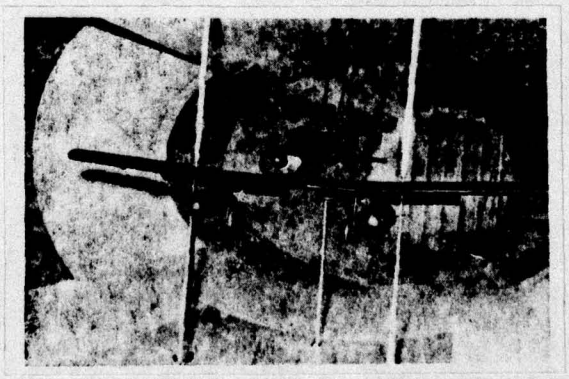


Photo Caption: Testing the aerodynamic characteristics of model airplanes in the T-32 wind tunnel

Highest velocity, 72 meters/second, with the possibility of a gradual change starting with 2 meters/second.

Turbulence: factor 1.07 (by means of a sphere),
Reynolds number, 500,000 per dm,
Original pressure, atmospheric pressure,
Scale (mechanical) tricomponent,
Windmills (transverse and deflecting),
Pressure measurement by means of water multi-manometer (photographing).

Visualization of circulation by means of string and smoke.

In addition to purely aerodynamical testing, for which purpose this wind tunnel is primarily equipped, it is possible to perform a whole series of tests of the non-aeronautical character without any or with very small adaptations.

All kinds of calibrations of anemometers come into consideration, providing they do not exceed the effective space of the operating part.

It is possible to carry out with precision the visualizations of circulation linings of buildings, smokestacks, ships, etc., with the possibility of photographing the flows and possible measurements of the fields of velocity and pressure.

Models of rail- and road vehicles can be tested with the purpose of improving the shapes to decrease the motion resistance.

With some adaptations it is possible to test the models of bridges, TV towers, power lines, etc., both regarding the air resistance to relative wind and regarding vibrations and deformations.

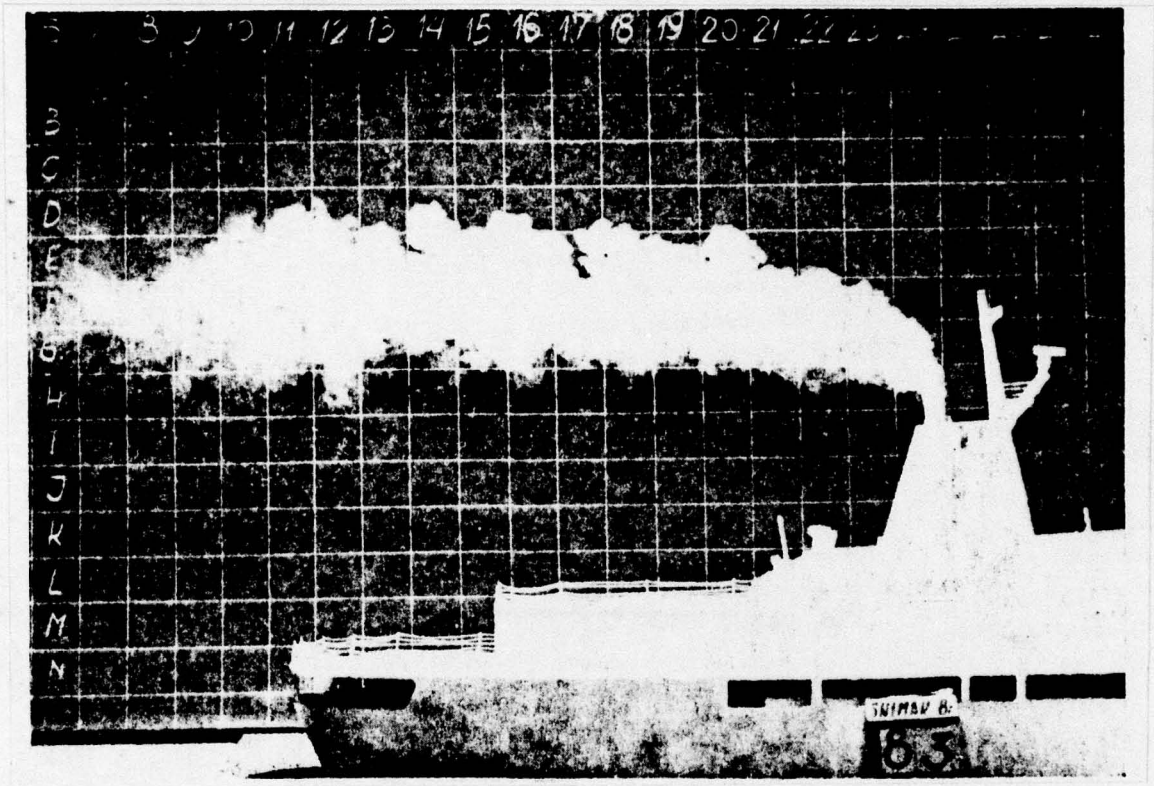


Photo Caption: Testing the ship's smokestacks in the T-32 wind tunnel

THE T-33 WATER-CAVITATION WIND TUNNEL

Intended as a wind tunnel - twin of the small T-32 subsonic wind tunnel, regarding the power capacity. In operation since 1952.

The operating part is closed, 0.50 meters wide, 0.35 meters high, and 0.50 meters in length, and is converted into an octogon by cutting corners under 45° every 0.1 meter.

Of standard design with 4 joints, made of steel sheet metal and reinforced concrete, total length 25 meters. Set up in the vertical

plane.

Contraction 4, filter of honeycomb shape.

Power capacity, 110 kW (in alternation with T-32 wind tunnel).

Three-bladed fan 0.8 meters in diameter, made of bronze (brass).

Highest water velocity, 11 meters/second.

Reynolds number, 100,000 per cm.

Original pressure, max 1.5 atmosphere, min. 0.01 at.

Observation of cavitation phenomena.

Speeding up the cavitation phenomenon by controlling the air content in suspension.

Photo Caption: Model airplane in the T-33 water-cavitation wind tunnel

Analogy, cavitation in water - shock wave in the air.

This wind tunnel was intended in its time to fill the gap felt in the field of high subsonic velocities, i.e. primarily leaning toward the possibility to use the analogy between the cavitation phenomenon in water on one hand and the formation of a shock wave in the air on the other hand.

But the possibilities of using this wind tunnel for many hydrotechnical problems outside the aeronautical field are not precluded.

Thus, the calibration of odometers for water flows of smaller dimensions come into consideration.

Studying the resistance of shapes of submerged parts of the ships or traction elements.

With some adaptations it is possible to observe and analyze the cavitation phenomena in models, or the ship's propellers proper of smaller dimensions.

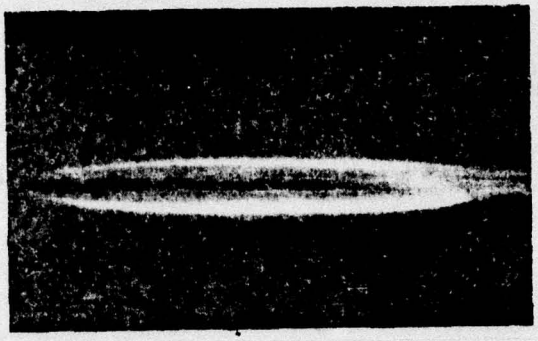


Photo Caption: Cavitation in the T-33 hydrodynamic wind tunnel

LARGE T-35 SUBSONIC AERODYNAMIC WIND TUNNEL

The concept, planning, and construction spanned the period from 1956 to 1964. Calibration, adaptations, and modifications are still going on in 1970.

The operating part closed, 4.4 meters wide, 3.2 meters high, approximately 4.0 meters long, gradually widening, the corners cut and approaching to the greatest extent the elliptical cross-section.

Standard design with 4 joints, total length 180 meters, with reinforced steel sheet metal of 10 millimeters. The total mass is approximately 1000 tons.

Contraction 7, filter - cooler.

Original pressure: atmospheric pressure (with possible later operation using under pressure).

Power capacity, 7200 kW (four motors coupled as one via a reductor) with the possibility of short-lived overload up to 10,000 kW.

The fan has a diameter of 8 m, is 12-bladed, and made of steel sheet metal.

The highest achieved velocity of the air current with the three coupled motors is 180 meters/second.

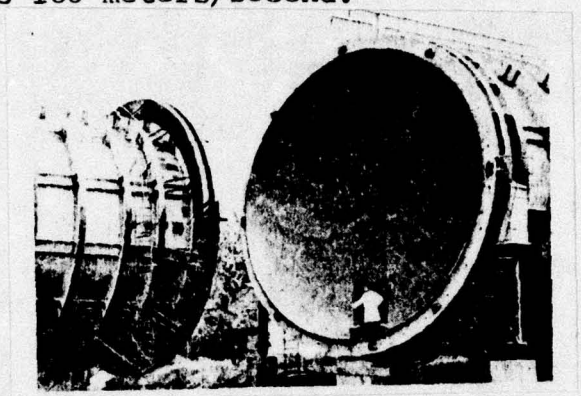


Photo Caption: Airplane wing in the T-35 wind tunnel

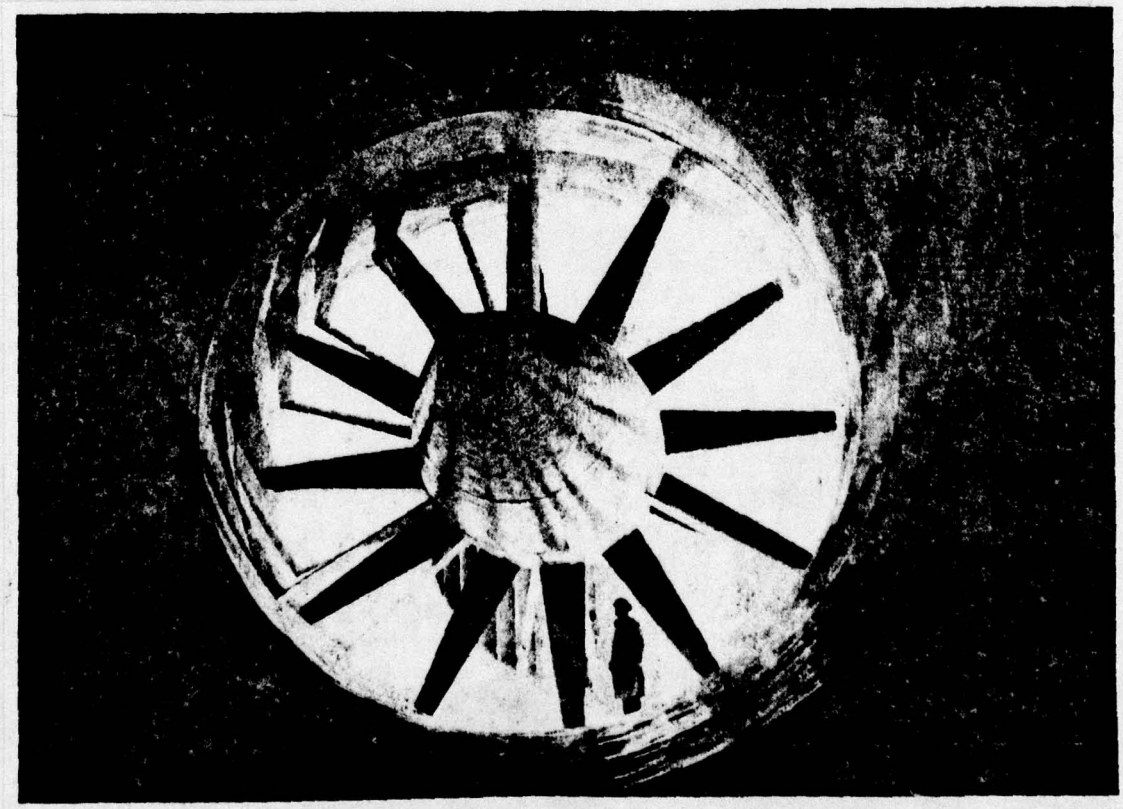


Photo Caption: Propulsion group of the T-35 wind tunnel

Turbulence factor, 1.25 (by means of a sphere).
Reynolds number, 10,000,000 per meter.
Six-component scale with the measuring tapes.
Windmills (transverse and deflecting).
Possibility of mounting of "measuring spear."

Two sets of interchangeable operating parts enable a greater utilization of time for the measurements proper. One is a steel structure (3.0 meters of effective length), the other is made of wood (4.5 meters of effective length).

Originally intended as a wind tunnel for aeronautical research in the field of high subsonic velocities, this wind tunnel can be used for a whole series of non-aeronautical problems.

Where the small subsonic T-32 wind tunnel could not satisfy, either due to limited dimensions of the operating part, or because of a relatively low maximum velocity, the large T-35 subsonic wind tunnel would be able to function more satisfactorily. Here one has to keep in mind the considerably higher costs of upkeep and operation and not even to count on the services of the non-aeronautical character of this wind tunnel if this is not absolutely essential, and in the small wind tunnel impossible to do.

Otherwise, thanks to the possibility of opening of the large joint, thus converting the wind tunnel into an open type, it is possible to obtain at the output of the large diffusor a fairly balanced air stream of approximately 30 meters/second (110 kilometers/hour) at the cross-section of the elliptical

shape 12 x 9 meters, where it would be possible to test also the objects under natural circumstances and under the conditions identical to hurricane-type storms.

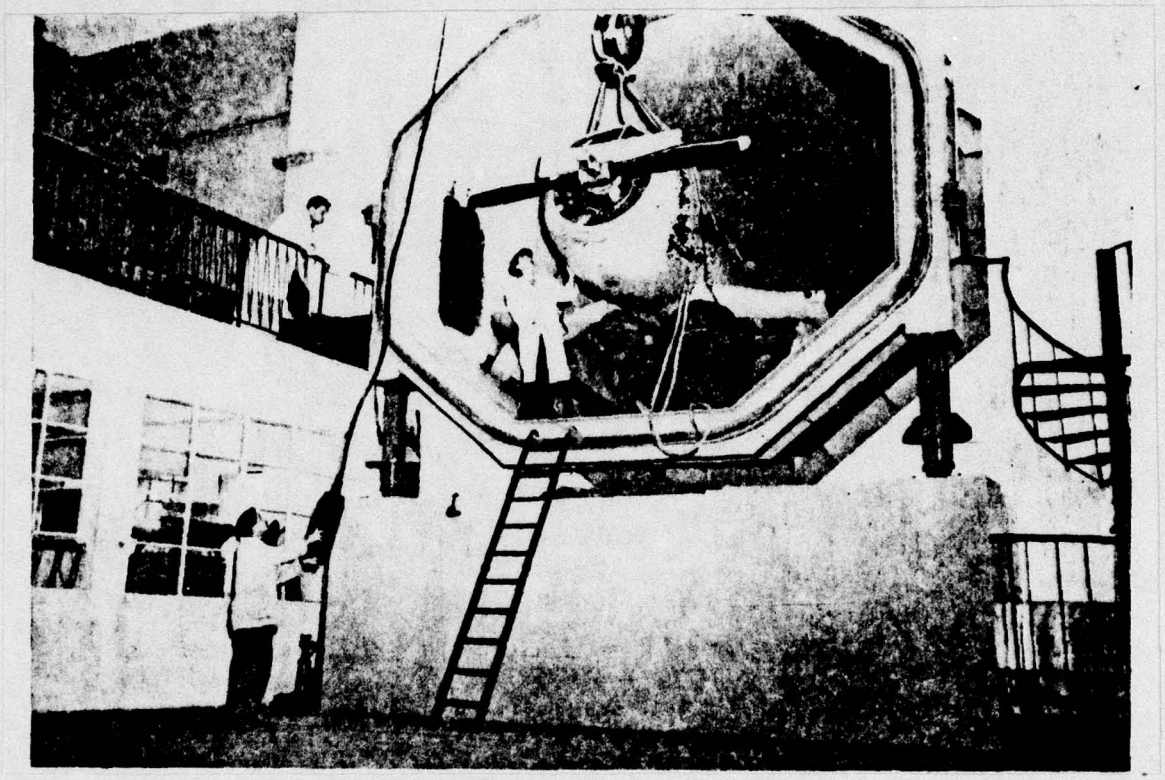


Photo Caption: Preparations for testing a propeller-driven airplane

TRANSONIC-SUPERSONIC T-36 AERODYNAMIC WIND TUNNEL

The planning and construction took place from 1954 to 1958. Calibrations, adaptations, and modifications are still under way in 1970.

The operating part is square, 0.25 x 0.25 meters, 0.6 meters long.

The wind tunnel part between the tanks has a total length of 10 meters, and has a reinforced steel structure.

The vacuum tank, 500 cubic meters in volume, is made of reinforced concrete. The tank of dry air, 1000 cubic meters in volume, is built with bricks (under atmospheric pressure).

Power capacity, 7 vacuum pumps having total power of 10 kW. Actual vacuum, 0.05 atmosphere.

The duration of a single blowing, 12 seconds every 30 minutes.

Mach numbers, 0.3 to 1.15 in the subsonic-transonic range; 1.36 - 1.56 - 1.86 - 2.48 - 3.24 in the supersonic range, through the exchange of jet blocks.

Reynolds number, 150,000 per centimeter.

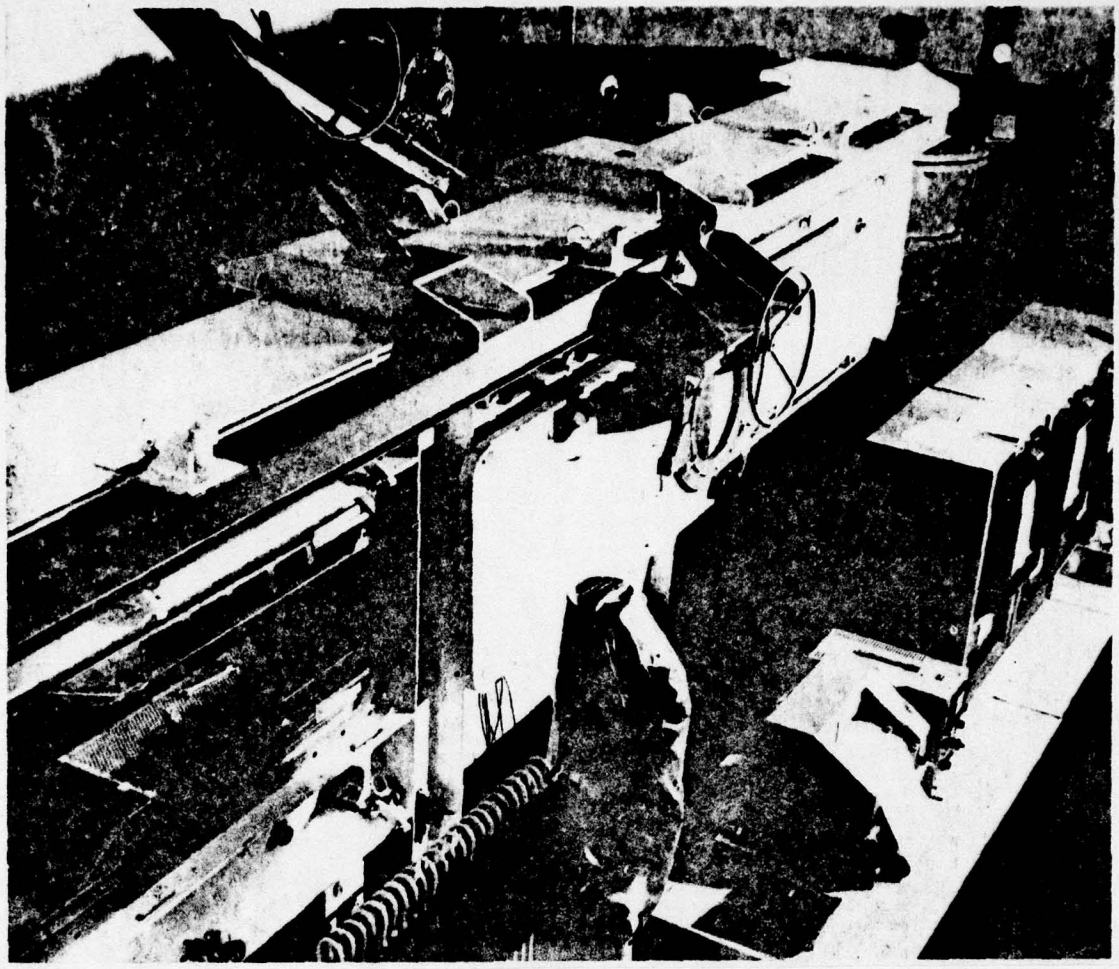


Photo Caption: Operating sector in transonic configuration of the T-36 aerodynamic wind tunnel

Measurements of the pressures by a multimanometer with a live and a "guillotine" switch.

Measurements of forces and moments by means of measuring tapes (mainly a separate adaptation for each model).

Observations and photographing of flow patterns by optical methods (Schlieren).

By its design the wind tunnel[15] intended exclusively for studying

of aeronautical problems in connection with high velocities (sonic and hypersonic). As such it can be also used for armament problems due to the common connection represented by the element of high velocity.

Since non-aeronautical problems (except armament) are rarely connected with air movements with a velocity which could be compared with the speed of sound, or to exceed it many times, they hardly have a chance to seek solution in this wind tunnel.

However, inasmuch as the wind tunnel itself with its specific requirements does not find application among non-aeronautical problems, the attached installations, as for instance the batteries of the vacuum pumps and vacuum tank, offers wide possibilities for its utilization in the form of versatile application of the vacuum.

The behavior of various assemblies and pipelines on compression due to external pressure, as well as the behavior of various equipment and instruments in the rarified medium could be the subject of testing in the vacuum installation of this wind tunnel with minor adaptations.

The possibilities of biological experiments associated with the existence of a vacuum are also not precluded.

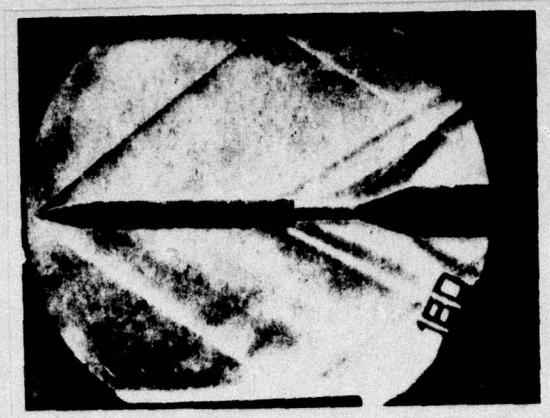


Photo Caption: Shock waves around the aerodynamic body in the hypersonic air currents of the T-36

AEROTHERMODYNAMIC LABORATORY

The aerothermodynamic laboratory is provided with a furnace built and intended for testing refractory partition panels 2.2 x 2.5 meters in size, which satisfies all the requirements of the International Convention on the protection of human lives, SOLAS - 1960.

During the combustion it is possible to program the time intensity of the temperature ranging from 20 to 1200°C. The temperature is measured at several points simultaneously by means of electronic instruments and is recorded on the tape.

Our tests and probing of partition walls made of refractory panels to be used in ship-building industry are recognized by Lloyd, the Yugoslav Registry, the USSR Registry, and by the Sudoimport of the USSR.

The workshop at "Aerodynamika" is equipped for fabrication of various models made of wood, metal, and araldite for testing in aerodynamic wind tunnels.

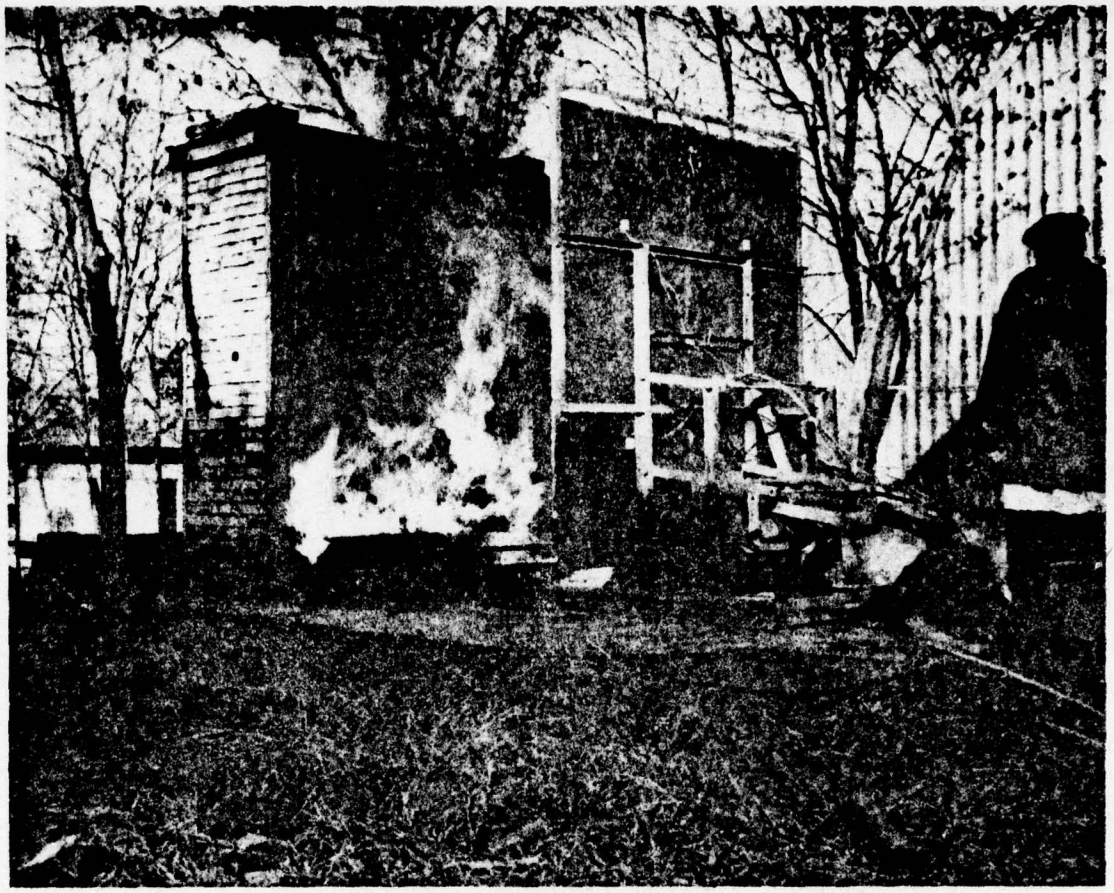
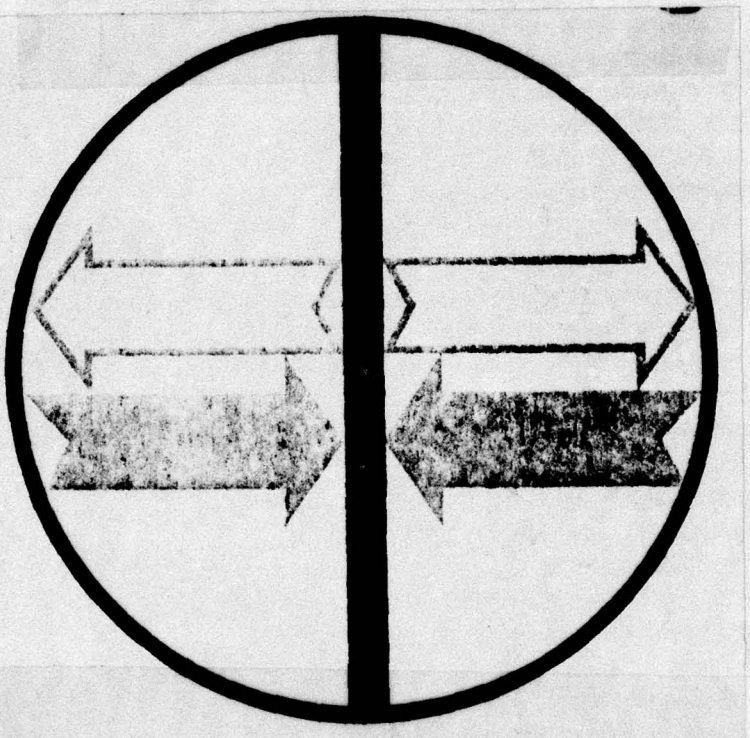


Photo Caption: Testing of refractory plates

S T R E N G T H



STRENGTH

Research scientific work in "Strength"* is one of the most vital phases for the successful completion of projects.

"Strength" is involved in all the theoretical and experimental problems associated with the strength of materials in the area of the scientific and applied research and development.

This activity encompasses the studying and setting of the requirements, conditions, and regulations, development and application of research methods, finding proofs from the whole field of the strength of structures and systems of various designs, and the issuance of technical documents on their strength.

The introduction of new materials and types of design also brings new problems, the solution for which can be found through theoretical or experimental research and testing performed with the aid of special installations for static and dynamic testing, or by means of separate equipment and instruments, many of which - available to the VTI - can be installed on the objects tested (e.g., bridge, turbine, ship, rail- or other vehicle).

If regulations for planning do not exist, even a mere requirement for strength represents a problem. Sometimes a related method of calculation is lacking, or the doubts in the accuracy of the calculations are so high that they should be supported by mechanical testing.

In its work so far, the "Čvrstoća" has made a very great contri-

*English translation of the word "Čvrstoća".

bution in designing the airplanes "Galeb," "Jastreb," and "Kraguj." An airplane as a design represents in itself a system that is infinitely statically indeterminate. However, the magnitude of static indeterminateness of the design does not manifest itself as a limitation in calculation because the VTI possesses a modern digital electronic computer SII 10070 of the third generation and of a high capacity and high number of operations. The computer enables a far more rapid and more qualitative treatment of the theoretical calculations, as well as various experimental data.

In the technological process, an ever-increasing significance is ascribed to aeroelastic stability and resistance to repeating loads. The determination of the fatigue limit or that of durability, rigidity and responses to vibrations of the aircraft, vehicles and their component parts, as well as the impact strength of the design, represent - in addition to the above-mentioned operations - a wide field of providing services for the calculation and test characters.

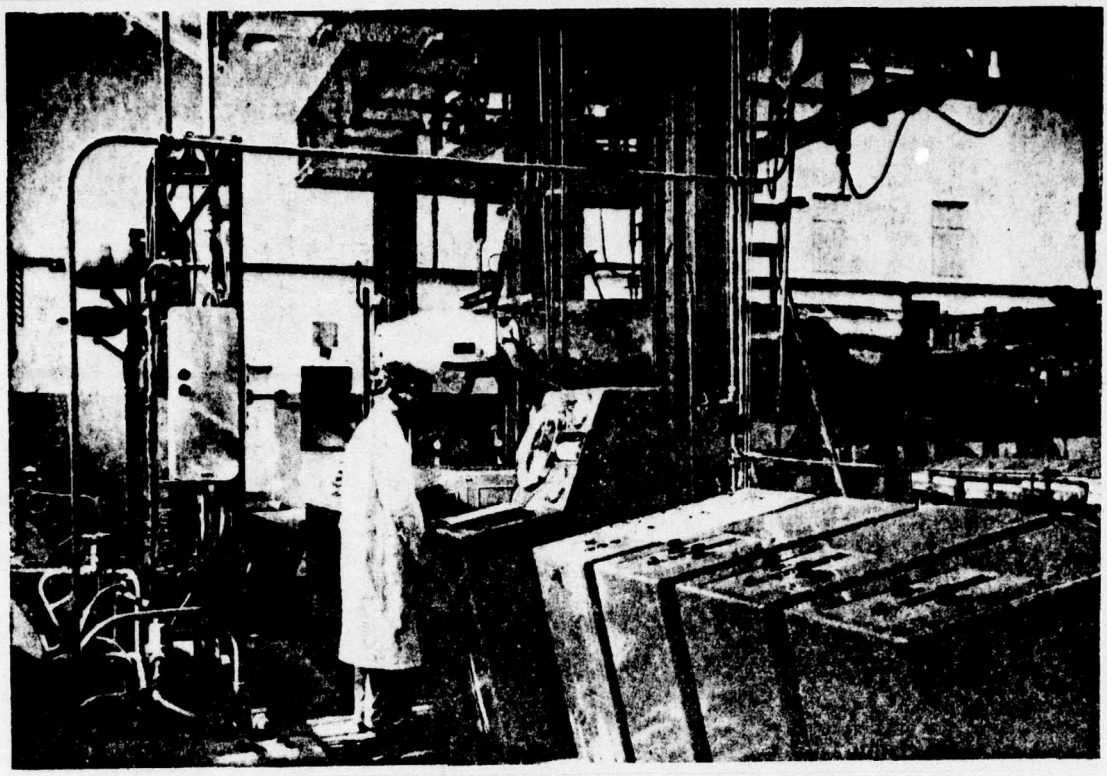


Photo Caption: Control panel of the hydraulic installation while testing the strength of the airplane fuselage in the static room.

The "Čvrstoća" is involved with the following activities:

CALCULATED STRUCTURAL STRENGTH

- Is engaged in the scientific and applied research in the area of calculated static and dynamic strength.
- Studies and development of methods for determination of static and dynamic loads.
- Studies and development of methods of structural analyses.
- Studies and develops methods of calculating static and dynamic structural strength.

- Studies of the conditions of loads and structural strength, and prescribes the conditions for the calculations.
- Takes part in initiation of new projects and their structures.
- Load calculations and sizing of structures.
- Load (stress) calculations and fatigue strength and determination of useful life.
- Publishes technical documentation for the strength of new materials.
- Prescribes the conditions for use of these materials relative to their strength.
- Takes part in the selection of materials and technological processes of new projects under development.
- Investigates the causes of structural failures and prescribes the procedures for their elimination.
- Analyzes the results of experimental strength and finds the proofs of structural strength.

AEROELASTICITY AND VIBRATIONS

In the area of scientific research it is engaged in:

- Studies and development of methods of structural analyses for the application relative to the problems of aeroelasticity and vibrations.

- Studies and development of the methods for determination of nonstationary aerodynamic forces.
- Development of methods for testing of aeroelastic properties and issuing of regulations and instructions for calculated and experimental safeguarding from negative influences due to

vibrational phenomena.

Within the framework of the research applied it encompasses:

- Participation in the initiation of structures of new designs and from the viewpoint of aeroeslaticity.
- Calculation of elastic, inertial, and vibrational characteristics of the structure.
- Calculation of critical velocities on the basis of theoretical and experimental data.
- Determination of stationary and nonstationary aerodynamic forces for aeroelasticity calculations.
- Testing of rigidity and vibrations of the structures and the systems.
- Research in the causes and method of elimination of unfavorable aeroelastic and vibrational phenomena.
- Provides proofs (attestations) for given materials relative to their rigidity and vibrations.

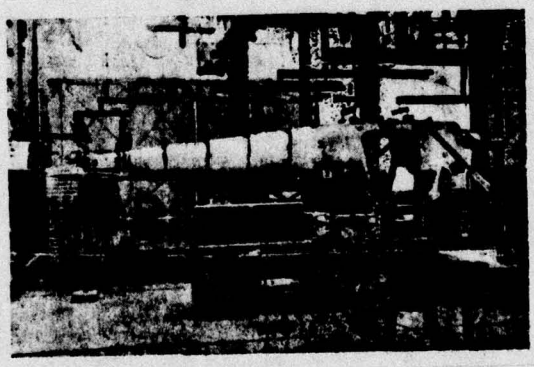


Photo Caption: Testing the strength of an airplane fuselage

TESTING OF THE MATERIALS (MATERIALS LABORATORY)

Special attention is given to the testing of materials due to the significance of maximal utilization of materials along with

the safety factor which must be satisfied:

- This laboratory is engaged in the scientific and applied research and standard materials testing (metals and nonmetals), studies their properties and applications. Studies and develops destructive and nondestructive testing methods of the characteristics and quality of the materials and the elements.
- Specifies and makes the selection of the materials and semi-finished products, technological processes for the treatment and protection of new structural materials.
- Specifies the testing apparatus and the setups for the laboratories.
- Prescribes quality control procedures and technical conditions for the receiving of the materials and products.
- Investigates the causes and ways of elimination of material failures.
- Calibrates testing devices.
- Performs quality control, determines the reliability and interchangeability, issues attestations, certifications, and experts' opinions.

The laboratory in its theoretical and experimental work utilizes the voluminous fund of the available documentation.

It disposes with the most advanced devices, installations, and instruments for carrying out the prescribed and programmed defect structure, metallographic, mechanical (static dynamic), chemical, and other kinds of testing.

Performs testing of strength at elevated and low temperatures until destruction as well as nondestructive testing (X-ray, ultra-

sonic), and analysis of the stressed state at the surface of the model by the application of brittle lacquers.

The aforementioned operations of the materials laboratory can briefly be summarized into research and testing of all kinds of metals, structural elements and finished products, and nonmetal testing, such as: textiles, rubber, plastics, leather, glass, wood, resins, and others, for the purpose of:

- research,
- homologation,
- arbitration,
- identification,
- proof of quality.

With the purpose of information and closer scrutiny of testing possibilities we are presenting an overview of the materials tested. For each of the mentioned areas or materials the testing programs are determined on the basis of the standard.

A. MATERIALS

Metals and alloys - semi-finished products

Statics, dynamics, metallography.

Metals and alloys - structural parts

Forgings, castings, various carriers, joints and couplings (fastened with nuts, welded, glued), moldings, connections, cogwheels.

Metals and alloys - finished products

Coil springs, leaf springs, steel ropes, Galle's chains, ball bearings, rivets, bolts, Dzus fasteners, split pins.

Photo Caption: Fatigue testing of connection with bolts using a 50-ton hydraulic pulsator

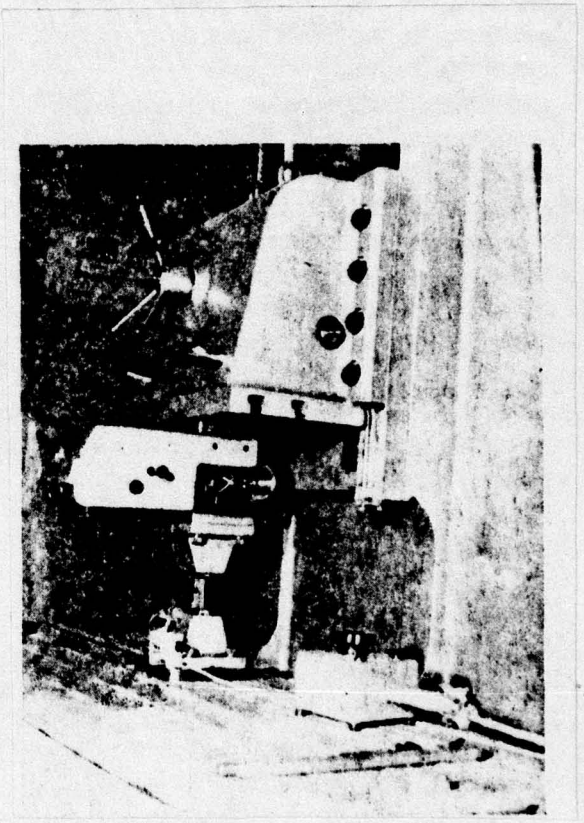


Photo Caption: Pulsator for fatigue testing of materials

Rubber and rubber products

Sheet rubber, foil rubber, foam rubber, rubber membrane, gaskets, various rubber hoses and pipelines, rubber ropes, and various

rubber shock absorbers.

Plastics

Polyvinyl chloride (plates, pipes, foils, leather, foamed), acrylic glass (plexiglass), styropore, moltoprene, bakelite, textilite, fiber, fiberglass, resins, as well as products (such as helmets, sandwich materials, mattresses, etc.)

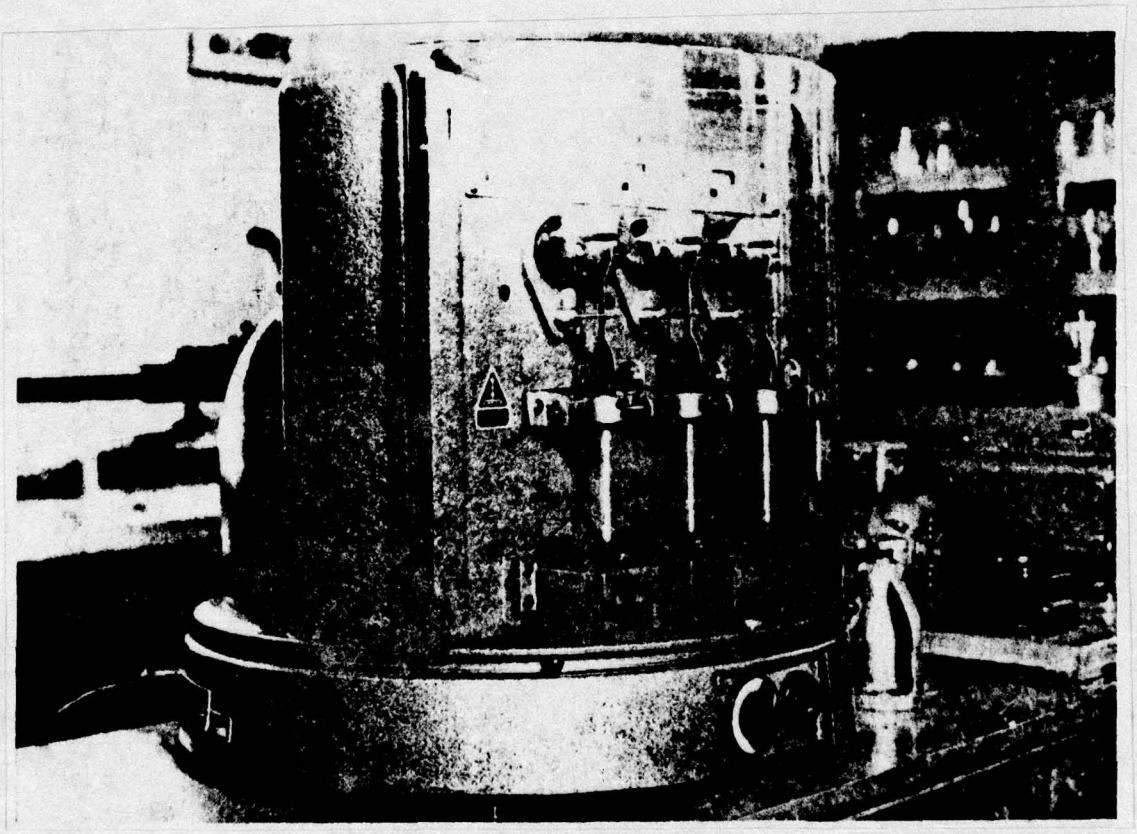


Photo Caption: Apparatus for testing plastic materials for fatigue by bending

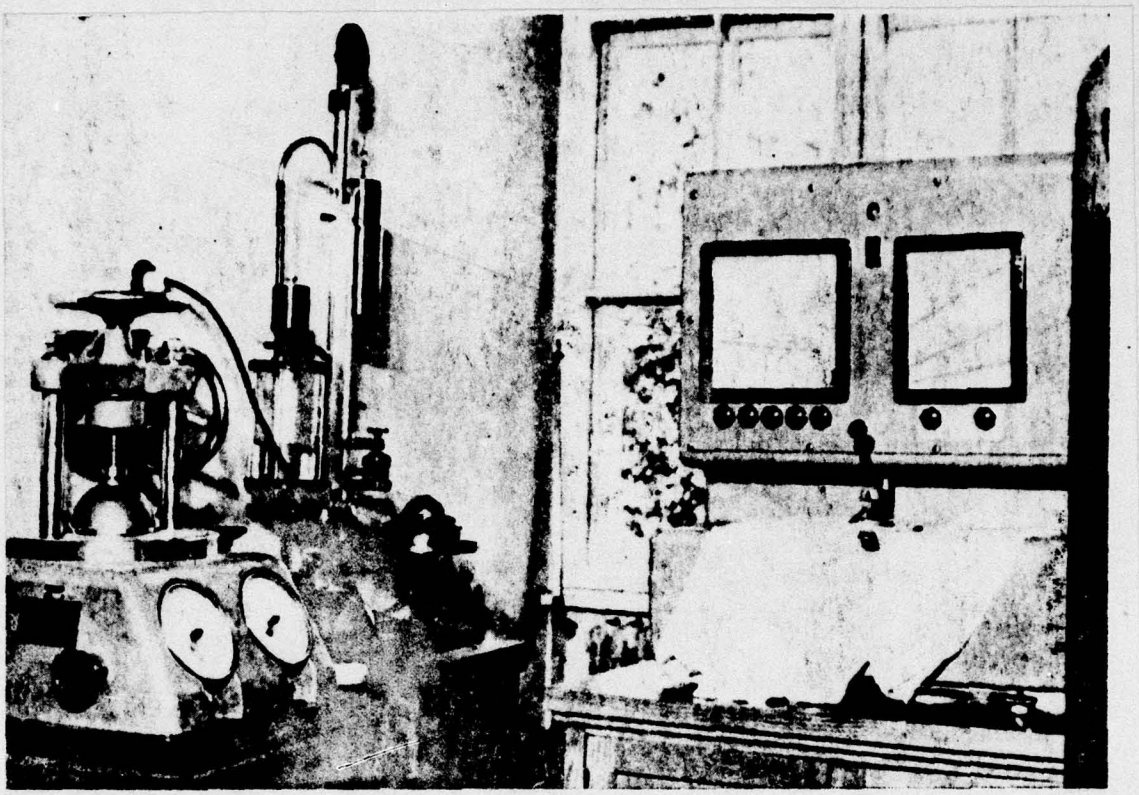


Photo Caption: A part of the laboratory equipment for testing of nonmetals.

Wood

Wood, veneer, glue, lesonite, splinters, panelling, enriched wood (lignofil and similar).

Glass

Plate glass (generally founded), laminar glass, panel glass, glass bottles, and glass cloth.

Textile

Fabrics, belts and bands, ropes, and cords.

Leather

Calfskin, leather sole, shoulder straps.

The above-mentioned materials are a part of regular routine-standard testing. However, there is a possibility of determining the testing programs per special requirements.

* * *

B. DEFECT STRUCTURE STUDY

- X-ray,
- Ultrasound,
- Magnetic defect structure study.

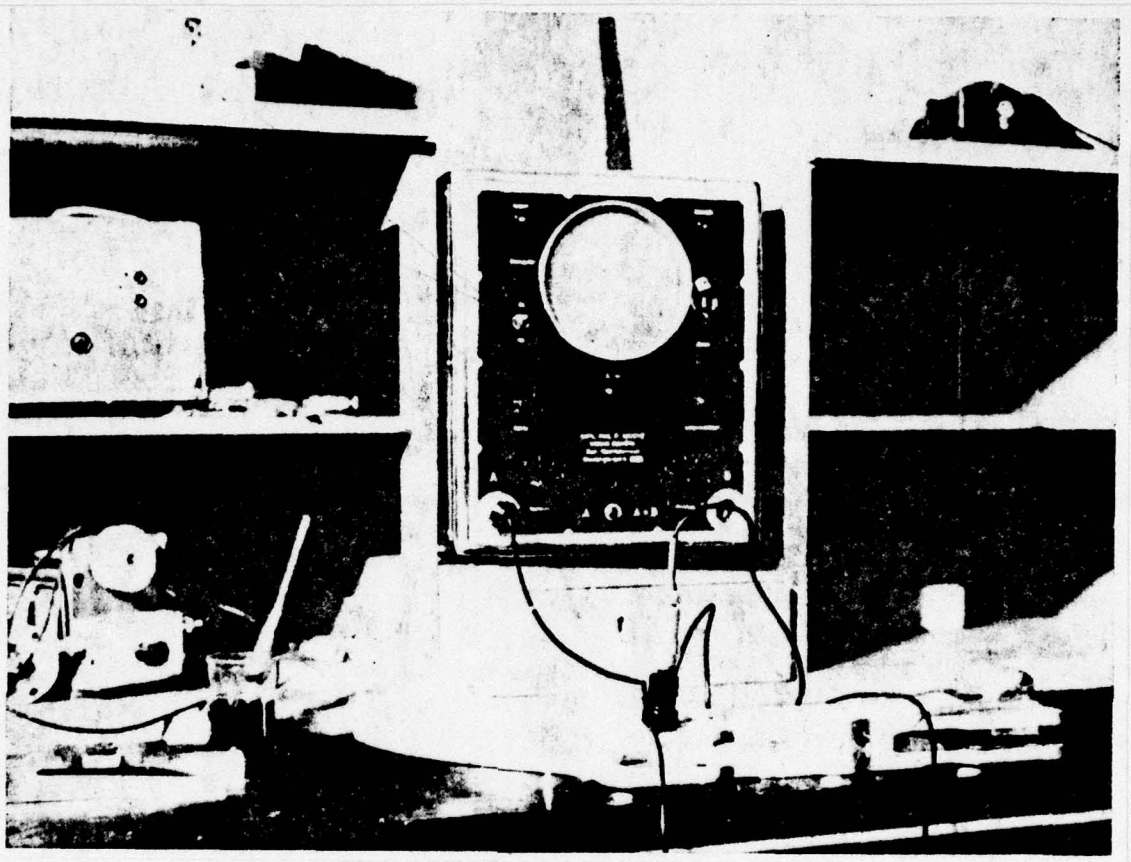


Photo Caption: Ultrasonic apparatus for defect structure study of materials

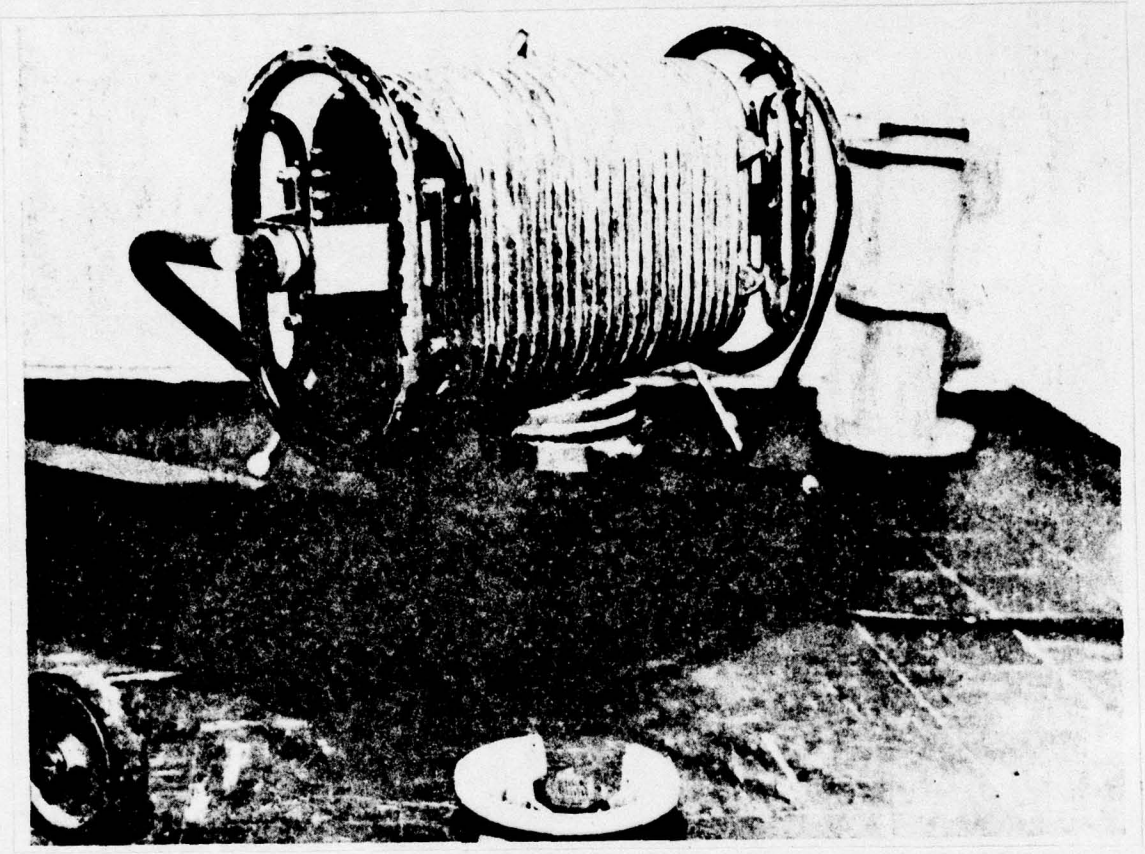


Photo Caption: X-ray setup for the testing of defect structure of materials

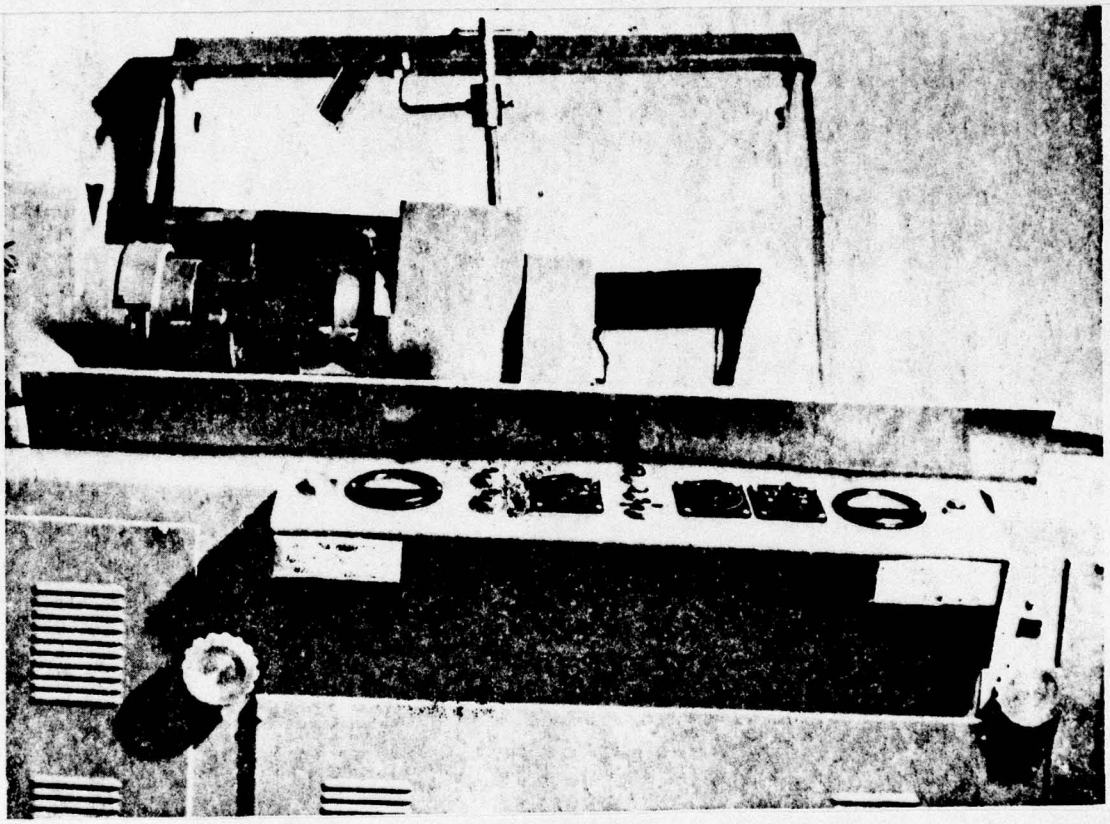


Photo Caption:Ferroflux for defect structure testing using the magnetic method

C. CALIBRATIONS

- Rupture tester and presses,
- Hardness testing apparatus,
- Charpy pendulum hammer (Amsler),
- Dynamometers,
- Standards for el. and electronic balances,
- Measuring pointers (stings).

Special testing, research, and other operations not falling under the standard testing,, such as, investigation of failure causes, formulation of technical conditions, etc., are determined under their individual special programs.

EXPERIMENTAL STRUCTURAL STRENGTH

is concerned with scientific and applied research which includes:

- Studies and development of methods for testing of static and dynamic strength and fatigue strength.
- Specifies, designs, and develops the required testing equipment.
- Takes part in the specification and selection of the measuring apparatus for measuring tension, deformation, and creep of the structure.
- Programs, prepares, and carries out research on strength and publishes technical documents on experimental strength.
- Takes part in defining structures needed for testing new materials, and prescribes the procedures for receiving materials for testing.

- Takes part in research in the causes of structural failure.
- Research is done with the most modern regulations chosen by the client, or according to his special requirements.
- Through current research and testing of aircraft and other flying machines and designs, both for the Yugoslav People's Army and for the needs of the economy, valuable experience and reputation have been acquired for the contemporary testing laboratory for the structural strength.

The laboratory for experimental structural strength is equipped with a modern setup of the hydraulic type, which comprises the needed apparatus for:

- introducing static loads,
- testing with forces of various gradients, and
- programmed testing for fatigue, along with all the necessary equipment for recording and measuring.

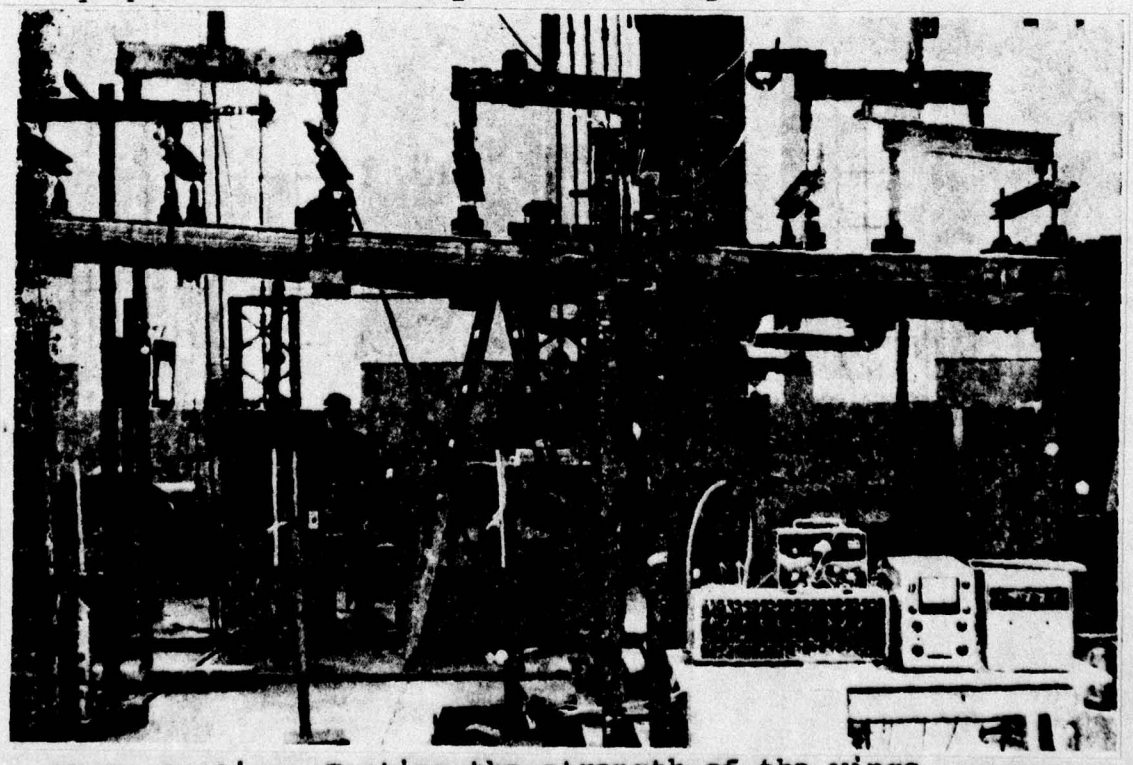


Photo Caption: Testing the strength of the wings

LABORATORY FOR ELECTRONIC MEASUREMENTS BY ELECTRIC AND ELECTRONIC MEANS

The modern overall technical progress in all the fields of the research scientific and exploitation activity led to revolutionary changes in the area of measuring the mechanical magnitudes. The existing classical methods are being replaced by the modern electronic methods with their numerous advantages: easy tracing and recording of the most complex measurements (static, dynamic, vibrational, and impact magnitudes).

This laboratory is engaged in the scientific and applied research in the area of the measuring technology of non-electric magnitudes by electric and electronic ways within the area of scientific and applied strength research, and takes part in experimental research.

By means of a mobile laboratory one can perform by electronic means the static and dynamic research at the site of the object tested (for instance, bridge, turbine, ship, rail- or other vehicle).

Within the scope of its activity it performs specific tasks:
- Study and development of measuring methods of non-electric magnitudes, and analyzes the results of these measurements.
- Specification of the measuring equipment.
- Complex tasks from the area of measurements and analysis of non-electric magnitudes by electronic means, such as: static and dynamic relative deformations and stresses at a large number of measured points (several hundred) and simultaneous

recording on multiple channels (twelve). Vibrational displacement in the velocity and acceleration. Vibrational characteristics and durability of the structures and systems. Static and quasi-static displacements of the structures. Thrust, pressure, temperature, flow, rpm, etc.

- Homologational testing and calibration of the vibration recorder.
- Measurements and analyses of creep and steady-state conditions on mechanical structures and electrical equipment.
- Measurements of nonlinear attenuation coefficients and dynamic elastic moduli of elements for amortization.

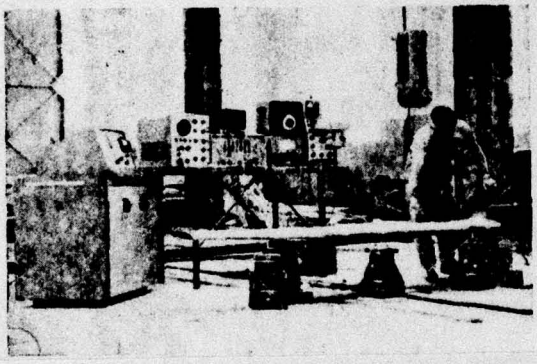


Photo Caption: Investigation of dynamic characteristics of elements of the airplane

- Measurement and frequency analysis of acoustic magnitudes (absorption and isolation coefficient, sonic pressure level, acoustical impedance of the samples, etc.) and research in the area of acoustics.

For all the listed functions of the laboratory there is available a highly skilled staff and most modern equipment and instruments. The level and precision of the measurements performed completely satisfies the requirements predicted by

the most stringent regulations and testing norms.

So far the laboratory has successfully performed a number of tests for the needs of the economy. Below are cited the examples of some of the tests by the areas:

- Measurements of deformation and tension by measuring tapes.
- Successive measurements of static deformation at 350 points per cycle. The range of measurements is from 2 to 2000 micro-deformations, depending on the measuring tapes. The results obtained are recorded by an indicator, a recorder, or a digital system. It is possible to simultaneously perform the measurements and recordings of dynamic deformations on 12 measuring channels with the stationary, mobile, and rotational components of the object measured.

- Examples of measurements performed.

Testing the static tension of the new Sava River bridge in Belgrade at 300 points.

Measurements of the tension of fan blades during operation at the Kolubara thermoelectric plant. Testing of railway car structures for the Goša factory at Smederevska Palanka, and MIN at Niš.

Deformation and tension measurements on floating platforms in Split and Rijeka.

Deformation measurements of homesites for explosive protection for the "Rade Koncar" factory in Zagreb.

- Measurements and analyses of mechanical vibrations.
- Measurement of mechanical vibrations during the operation of the motor, transportation vehicles, and other machinery. Frequency

analysis of the measured phenomena and confirmation of the reasons for the abnormal states and ruptures.

The frequency range of the measurements extends from 0 to 10,000 Hz. The measuring sensitivity is 1 microdeformation. The obtainment of the result is by direct display of the measured form of the vibrations or by recording by means of fast recorders or cameras.

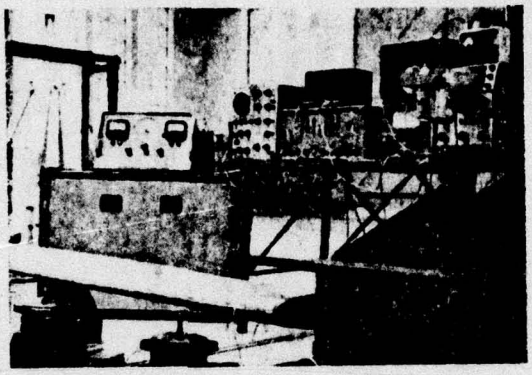


Photo Caption: Study of natural frequency of ventilator blades

- Examples of the measurements performed.

Measurement of the vibrations on the vehicles of City of Belgrade communications network.

Measurement of the vibrations of aircraft in air as well as on the ground.

Measurement and analysis of vibrations on torpedo boats.

Measurement of vibrations of Toplana--Novi Beograd turbines.

Measurement of vibrations transfer to the walls of the buildings of the Belgrade Geographical Institute.

- Temperature measurements.

Precision measurements of the temperature by means of heat elements, resistance electric thermometers, and thermistors. Plan-

ning and installation of temperature measurement setups. Control and calibration of thermal indicators, temperature regulators, and other devices. The range of measurements that can be done by heat elements is from $-150^{o}C$ to $1800^{o}C$. The range of the measurements that can be done by means of resistance elements and thermistors is from $-50^{o}C$ to $200^{o}C$.

- Examples of the measurements performed.

Control and calibration of thermal indicators of the electrical furnace Krušik--Valjevo enterprise. Measurement of the temperature on Vitez engines, Sarajevo.

Correction, control, and calibration of pyrometers for Insa enterprise in Zemun.

Installation of temperature-measuring setups for Rakovica induction motors.

- Measurement of the force, moment, pressure, flow, revolution number, and so on. Simultaneous measurement and recording of various physical and mechanical magnitudes. Measurement of forces from 0 to 10,000 dN (kg). Measurement of torsional moment from 0 to 200 dNm (kg m). Measurement of acceleration from 0 to 200 g. Measurement of displacement (play) from 0 to $\pm$ 50 (mm). Measurement of the pressure from 0 to $350 \cdot 10^{5} \frac{N}{m^{2}}$ $350 \frac{kg}{cm^{2}}$)[sic].Measurement of fluid flow from 0 to 10 liter/minute. Measurement of the rpm from 0 to several ten thousand rpm.

- Examples of the measurements performed

Complex testing of a special trailer driven by an attached shaft

done by the Zemun Polje Institute for mechanization of agri-economy.

Testing of hydraulic pumps and landing gears in the Prva Petoljetka (First Five -Year Plan) enterprise in Trstenik. Development of a method for the measurement of the chemically active fluid of IPT, Belgrade.

Complex testing of turbine wheels for the Bajina Bašta power station.

- Vibrational testing of mechanical structures.
Testing for the effect of vibrations of various components of devices relative to their overall technical characteristics. Frequency range from 3 Hz to 5000. The power of the amplifier 200W and 60W. Static load to 100 kg. Power of the amplifier 1250 kVA.

- Examples of the measurements performed
Testing of the homesite for the mine transformer of the Rade Končar enterprise in Zagreb.
Vibrational testing of VTI airplane structures in Žarkovo.
Testing of the detonator intended for the Krušik Valjevo enterprise.
Testing of the fuel storage tank.

- Testing of dynamic properties of shock absorbers and elastic components. Testing of natural frequency, dynamic modulus of elasticity, dynamics, rigidity, attenuation coefficient, etc. Frequency range from 2 Hz to 5000 Hz. Static overload from 0 to 150 kg. Dynamic induction force from 0 to 150 dN (kg). The

amplitude of the dynamic measurement being from 0 to 10 mm.

- Examples of measurements performed

Testing of rubber shock absorbers on the chassis of the Fiat 1300 engine made for the GIP enterprise in Pančevo.

Testing of nonstandard rubber shock absorbers for elastic support of the machines and equipment used by the shock absorber factory in Zvornik.

- Measurement and analysis of sonic processes.

Measurement and frequency analysis of noise on various facilities tested by the "Planning and designing of noise mufflers and acoustic insulation." Testing of acoustic properties of materials and machines. Frequency range 20 Hz to 20 kHz. Dynamic range up to 170 dB. Types of frequency analysis: Continual, 1 octave, 1/3 octave.

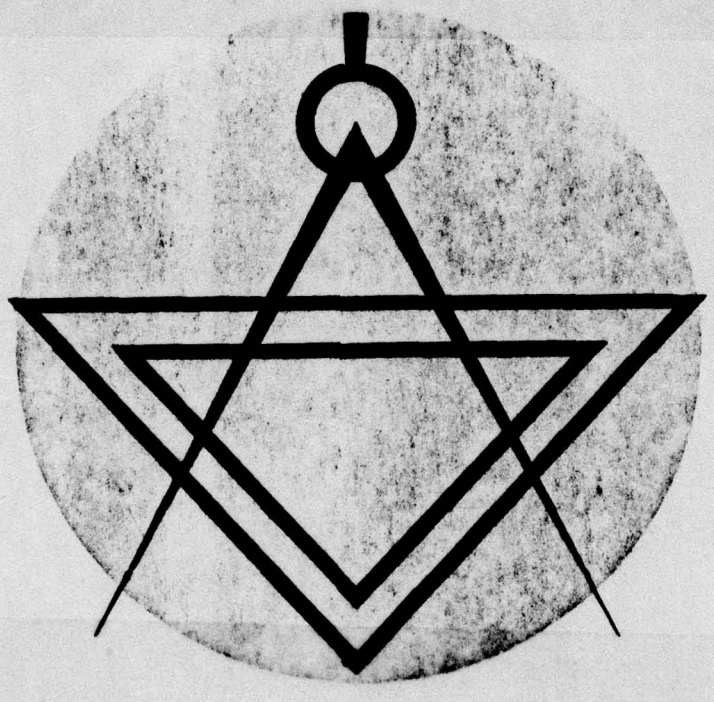
- Examples of measurements performed

Measurement and analysis of the 400 kW turbine assembly noise for the Jugoturbina enterprise in Karlovac. Testing of reduction properties of the muffler (attenuator) to be used in jet engines of the "21 May" Rakovica enterprise.

Measurement and analysis of noise in drive mechanisms RBT--Bor and IMR--Rakovica, as requested by the Institute for Industrial Medicine.

Measurement and analysis of noise in the working areas of airports and on the test stand of the engines.

D E S I G N



PLANNING AND DESIGN PHASE

The Aerodynamic Technical Institute offers in the planning and design phase the complete spectrum of engineering required, ranging from general studies and research operations, to planning, design, and receiving of the device or equipment into the construction phase, whereupon it can be experimentally tested.

The long-time expertise and expert and skilled staff which are available to the VTI relative to its planning and design activity makes it possible to successfully complete all and any tasks from the area of metal constructions and designs, including here shelled, grated, and other metal constructions, hydro-pneu-

Photo Caption: Design office

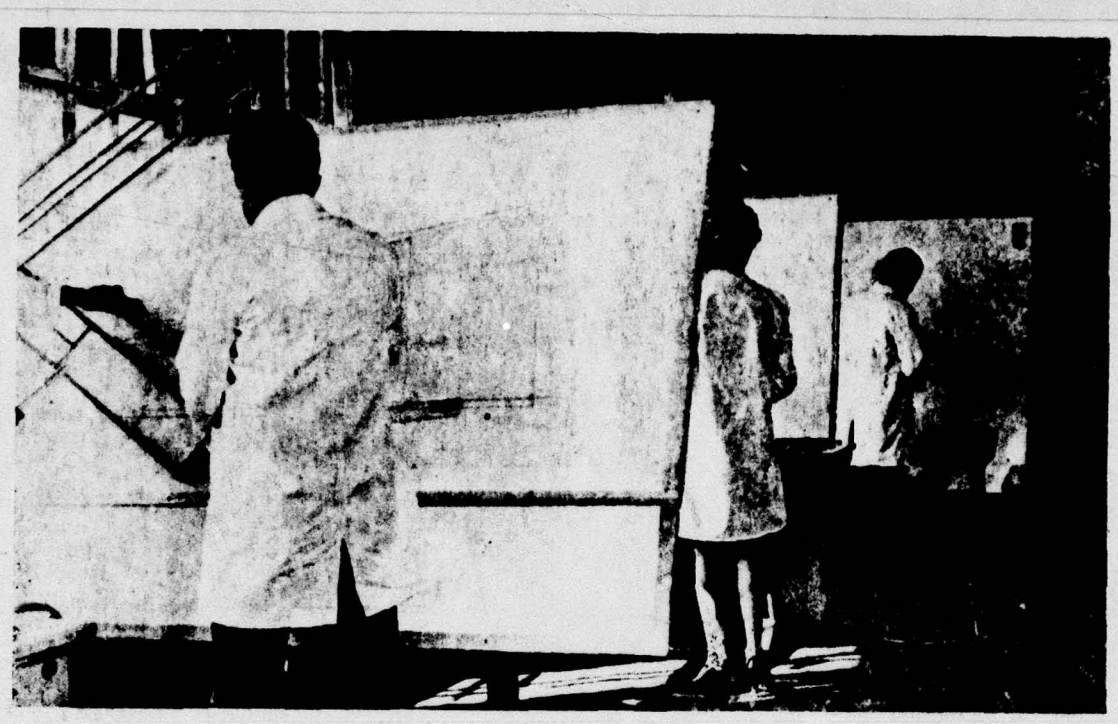


Photo Caption: Design office

matic installations, vehicular and ship components, shock absorption and braking devices, all kinds of measuring instruments and devices, as well as in the area of production development, technology, and production organization works.

Photo Caption: Design office

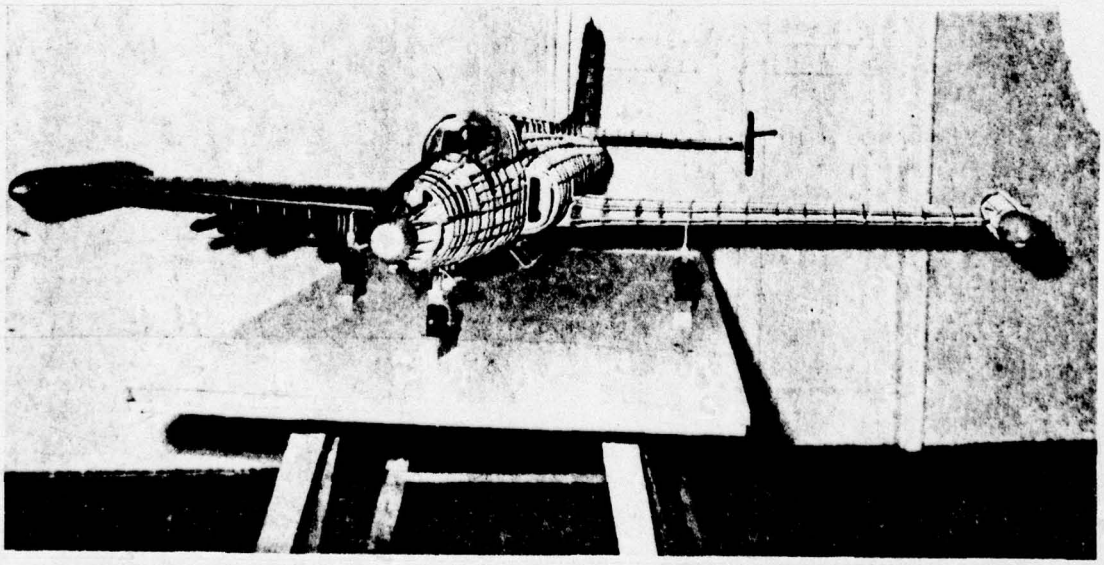


Photo Caption: "JASTREB" airplane model (JASTREB = Hawk)

During the recent period, the planning and design activity of the VTI has come up with a number of very important creations. According to our design plans, forecasts, workshop and other technical documentation the design plans for airplanes "Galeb" (Pidgeon), "Jastreb" (Hawk), and "Kraguj" (Vulture) have been developed, which in turn achieved great international acclaim at international exhibitions in London and Paris as being tops technologically in their category.

In regard to the specific conditions of aircraft planning and design, the striving for ever increased performance, as well as providing the maximum safety possible, the VTI planners and project engineers are capable of implementing novel design solutions on a continual basis.

The sphere of activity of the planning and design activity includes also the special complex designs of overhauling plants and workshops, their organization and working processes, as well as economical analyses.

Ground equipment designs and projects are necessary for the servicing of navigable facilities (such as landing strips at airports).

Planning and design for the installation of hydro-, electro-, electronic, pneumo-, and similar equipment, as well as counting and ventilation equipment, and so on.

The development of maintenance procedures, accompanying document-

ation of the navigable facility, revision of the design plan, mass production, as well as finalization of specifications and specific regulations.

It models design solutions (scaled wood material) to prove their validity in the development of the plan.

The VTI experts are ever ready to lend their technical assistance both in the planning and design as well as in the formation of planned economical aviation; they also provide the proper training for the staff so that these objectives can be achieved.

Civil aviation is using the airplane more and more as a medium which in its convenience is irreplaceable for certain functions. In agricultural economy we have the dusting of vast surfaces, fight against plant pests, fire protection of wide forest expanses, etc.

In the case of this category of airplanes, we have a convenient factor that airplanes of this type can be used for manifold applications with only minor modifications. The tourist airplane is entirely capable of serving as an airplane to be used for agricultural purposes, ambulance service, or reconnaissance operations.

The experts of the institute are prepared to provide their technical assistance both in the planning and in the formation of economical aviation, as well as in training their staffs for these purposes and operations.

Photo Caption: Model shop

WORKSHOP SERVICES

The experimental workshop for the processing of metals and wood materials which is assigned to VTI is equipped with modern precision machines, apparatus, and tools.

The workshop specializes in manufacture of tools, as well as of prototypes of machine and manual-tinsmith-locksmith production.

The machine section has a lathe and milling-grinding workshop. The lathe shop is equipped with large and small lathes for machining of parts up to Ø 700 (mm) in diameter and up to 2,000 (mm) in length, using an attachment which makes it possible to copy on the lathe - by means of a model standard - the machining of cones which are inclined at an angle of 9^{o} towards 500 (mm), as well as rounded objects. It machines all kinds of coils of the standard variety, and for precision grinding it uses a coordinate drill for holes up to Ø 300 x 300 (mm) in diameter.

Photo Caption: Machine shop

The milling workshop is equipped with smaller and larger universal milling machines for processing of component parts up to 300 x 700 (mm), which among others serve for cutting outer teeth

and fabrication of toothed wheels with various kinds of teeth of the 0.5-6 modulus, as well as other shapes of teeth for which

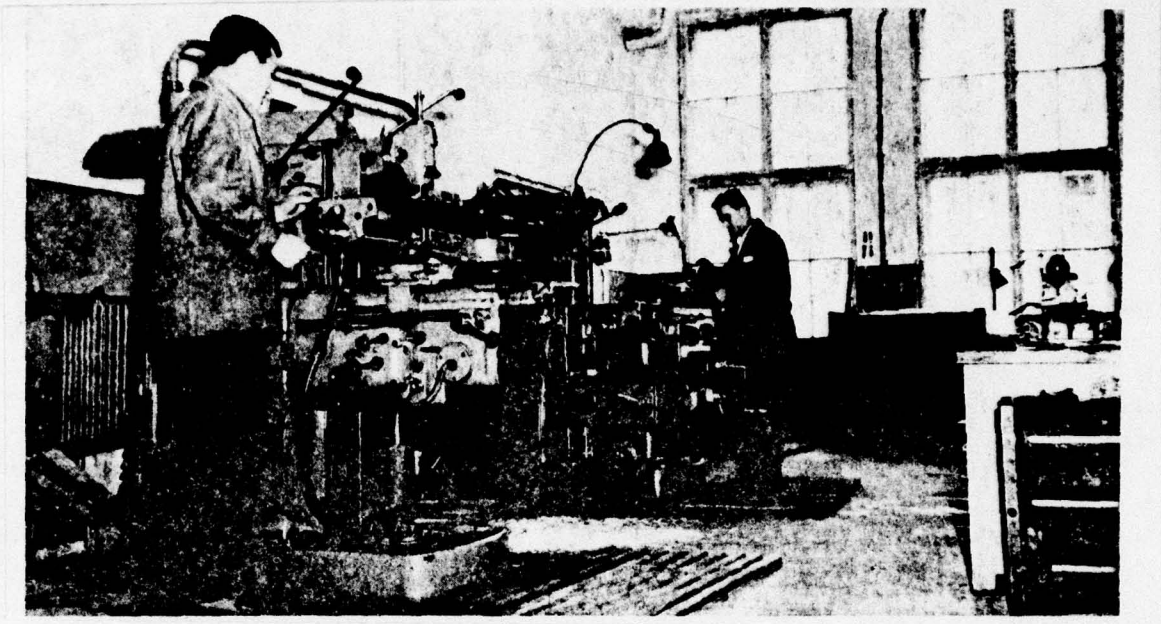


Photo Caption: Machine shop

the shop itself fabricates the tools. In addition, this shop is equipped with an assortment of universal grinders for level grinding of surfaces 200 x 500, the round exterior up to Ø 300 x 1000 mm, and the inner one up to Ø 200 x 400 (mm) and, furthermore it enables the fabrication of various kinds of chisel, control, and measuring tools, as well as the sharpening of dull tools.

The shop is also equipped with a horizontal planing machine for the fabrication of parts up to 600 x 350 mm in size.

A pantograph machine is used for relief treatment of surfaces, with various possibilities of enlarging the transferred magnitudes in ratios 1:1, 1:2, 1:3, and 1:4 on the total surface of 300 x 300 (mm).

All kinds of tinsmith-locksmith services can be performed in the manual tinsmith-locksmith-welding operations, as well as the forming by means of tools using a 600 x 700 (mm) press, extraction from a depth of 150 (mm), as well as all kinds of welding.

In addition, materials can be cut to a length of 2 m, and the thickness of steel sheet iron up to 4 mm.

The tinsmith shop is equipped with the machinery and tools necessary for forming complex parts, such as are found in aeronautical structures.

The capentry shop is equipped with modern machinery for the fabrication of wooden items (or plastic materials) in large numbers, various kinds of models and sets, as well as office and specialized furniture.

So far the operation of these shops, inspected through stringent controls customary in the field of aeronautics, confirmed the high degree of specialization and class of VTI workers, and hence also the quality of services mastered by VTI in this kind of production activity.

The experimental workshop has a very developed business cooperation with a number of factories in the Belgrade Basin, as well as with other enterprises throughout Yugoslavia.

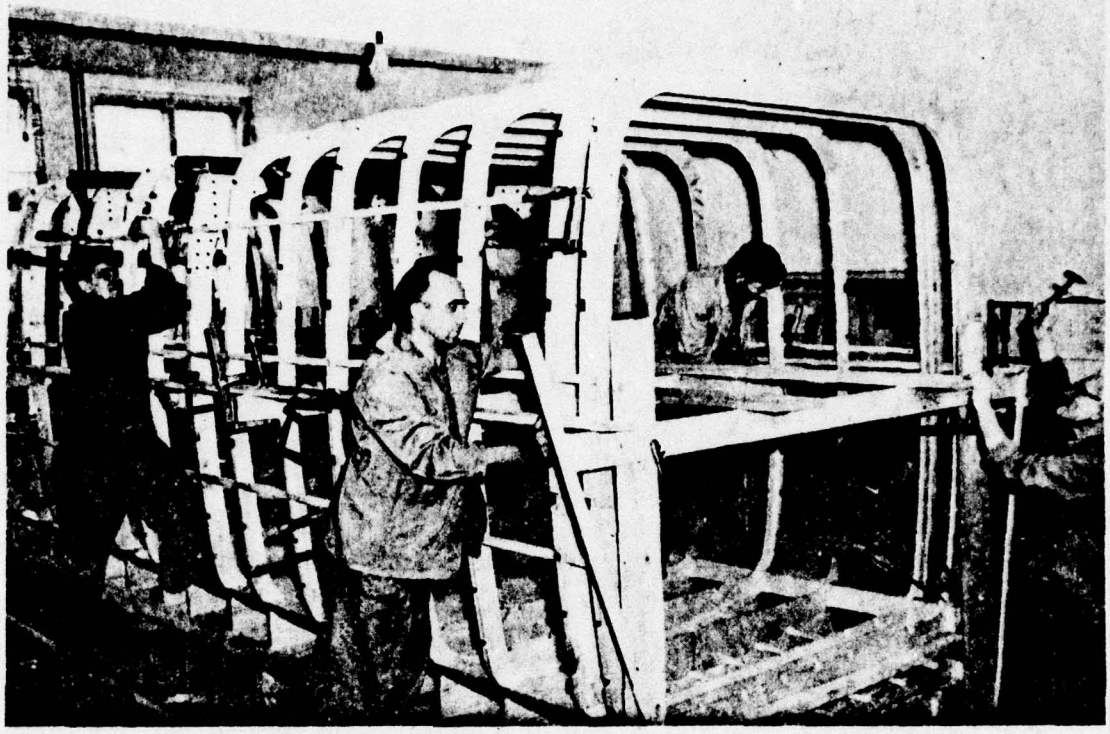
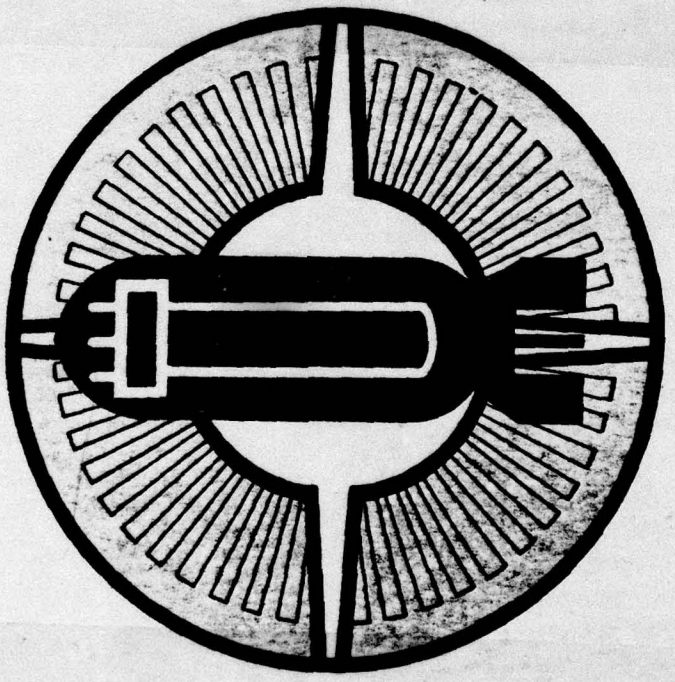


Photo Caption: Fabrication of wooden skeleton of an airplane

A C C E S S O R I E S



ACCESSORIES

The scientific research on equipment is distinguished by diversification, due to the heterogeneity of operations involved.

The testing is done by theoretical and analytical as well as experimental methods.

This activity comprises the studies, the issuance of requirements, conditions, and regulations, development and research, planning and fabrication of prototypes of aeronautical accessories with testing on special apparatus to check the quality, homologation, or issuance of attestations, as well as selection.

Accesories are made of the following services: electricity and electronics, armaments, engine, aircraft, and flying devices and instruments, and fuels and lubricants laboratory.

Photo Caption: Measuring the velocity of bullets

Photo Caption : Testing the sighting unit

ELECTRIC AND ELECTRONIC ACCESSORIES

In the area of scientific research this section is concerned with:
- studies, monitoring, and generation of information regarding contemporary technical state-of-the-art in the area of electric and electronic technology.

- selection of optimal electro-electronic accessories for the given purpose.
- investigation and analysis of the effect of various kinds of disturbances on the operation of the electronic accessories built into various units.
- investigation and analysis of the application of special electro-electronic materials and components.
- calculations and analyses of LF, VF, VVT, and UVF parameters of the antennae for various units.

In the area of planning it performs the following:
- realization of the plan relative to integration of electro-electronic accessories into various devices and units.
- planning and fabrication of transistorized low-frequency amplifiers.
- planning and fabrication of transistorized voltage regulators of single phase generators up to 20 kW.
- planning and fabrication of semiconductor voltage transformers of all kinds and for all operational conditions.
- planning and fabrication of electronic measuring and other devices for measuring and control of physical magnitudes.
- planning and fabrication of transistorized "mixer" devices for simultaneous reception of several signals (radio station, intercom, radio compass, and similar).
- calibration of signal generator (0-500 MHz), instruments for the measurement of single phase voltages, current, and resistance, frequency-meter (0-500 MHz), RLC measuring device, and so on.

- fabrication of technical conditions for the fabrication, homologation, and reception of electro-electronic accessories, materials, and components.
- generation of technical instructions, technical descriptions, and instructions for maintaining electronic equipment.

In addition to this, the electric and electronic accessories include analog electronic calculators for the solution of mathematical models, including here:
- Solutions of linear and nonlinear differential equations and systems of differential equations.
- Testing of stability, sensitivity, and invariability of the systems.
- Simulation of the physical model using mathematical models.

A brief overview of the tests performed.
- Testing of temperature coefficients of carbon resistors (Iskra in Kranj).
- Testing of automatic fuses (Teleoptik in Zemun).
- Testing of circuit breakers (Rudi Čajevac in Banja Luka).
- Testing voltage regulators for the TG-90 tractor ("14 oktobar" (October) Company in Kruševac).
- Testing automotive spark plugs (Trudbenik in Doboj).
- Testing light bulbs (IEV in Ljubljana).
- Testing airplane radio stations.
- Finding the critical speed of the "Galeb" airplane.
- Determination of zero polynomial of the flutter using analog computer.

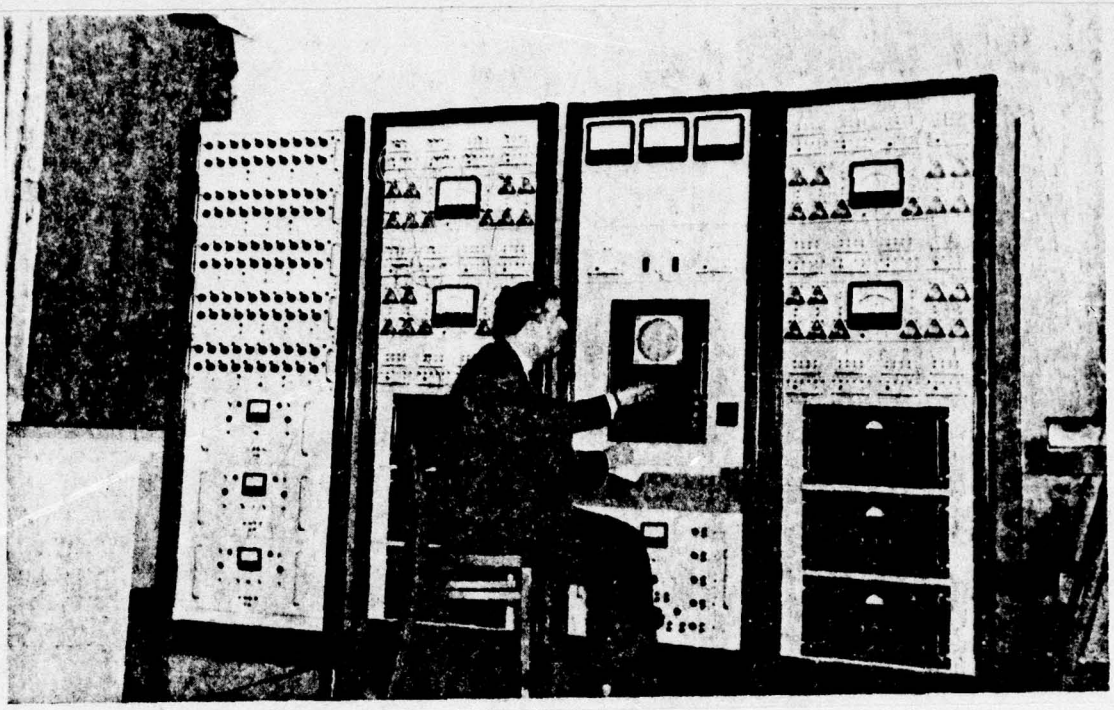


Photo Caption: Analog electronic computer

ENGINE SERVICE

In the area of scientific research it involves:

- Studies, aerothermodynamical calculations and analyses of the operating cycles of all kinds of internal combustion engines (piston, turbine, rocket).
- Selection of optimal uniform or combined propulsion group for a given application - (propulsion of aircraft, land and water transportation units, as well as stationary installations).

- Investigation of fluid flow phenomena (gases and liquids) through various components of the engine (induction, cylinders, compressors, combustion chambers, turbines, and exhausts) and auxiliary systems for the maintenance and regulation of the operation of the engine (installation of fuel and lubricants systems and regulators).
- Investigation, analysis, and selection of the optimal solutions: vibrations of engine components as well as those of the entire unit, noise suppression, heat exchange, thermal and mechanical durability of the materials used for vital engine components, characteristics of propulsion materials and their effect on the operation and durability of the engine and its components.
- Plans the following: integration of propulsion groups into all kinds of vehicles where internal combustion engines are used as the basic propulsion system (to wit, automobiles, buses, trucks, ships of all kinds and sizes, airplanes, and so on), as well as stationary installations where the propulsion is generated by internal combustion engines.

Fluid feeding systems and fuel lines for conduction of fluids for all kinds of machine installations.

Lubrication systems in machinery installations. Storage systems for fluids and lubricants.
- Develops technical conditions for homologation testing of all kinds and categories of engines, homologation of engine accessories; planning, development, integration, testing, application, maintenance, and repair of engines; installation of fuel and lubricants systems, and so on.

- Develops norms for standard parts and procedures used in planning, integration installation, and testing of propulsion groups, engine control systems, engine fuel feeding systems, and lubrication systems.

The engine service has a laboratory, devices, instruments, and checking station for performance testing of all kinds of internal combustion engines.

This laboratory performs scientific and applied research in the area of internal combustion engines, to determine:
- thermodynamic balance of the propulsion group as a whole and the degree of useability of individual parts;
- performance of propulsion groups on checking stations and in field operations, including here power and pressure measurements, specific fuel and lubricant consumption; behavior under most unfavorable conditions; extrapolation to standard conditions;
- homologation of propulsion installations for the given purposes;
- fluid flow; temperature, pressure, velocity, passage;
- heat exchange by transfer, conduction, and evaporation;
- measurement and analysis of sonic processes.

A brief overview of the operations performed:
- Measurement of thermodynamic parameters of the propulsion group.
- Testing of the operation of the LYCOMING piston engine.
- Measurement of the pressure of the jet propulsion group when hitched to other units.
- Measurement of the degree of usefulness of the oil cooler on piston engines.

- Measurement of flow and total fuel consumption as a function of the conditions under which the engine is operating.
- Measurement of the degree of usefulness of gas ejectors.
- Measurement of temperature and velocity field in gas current.

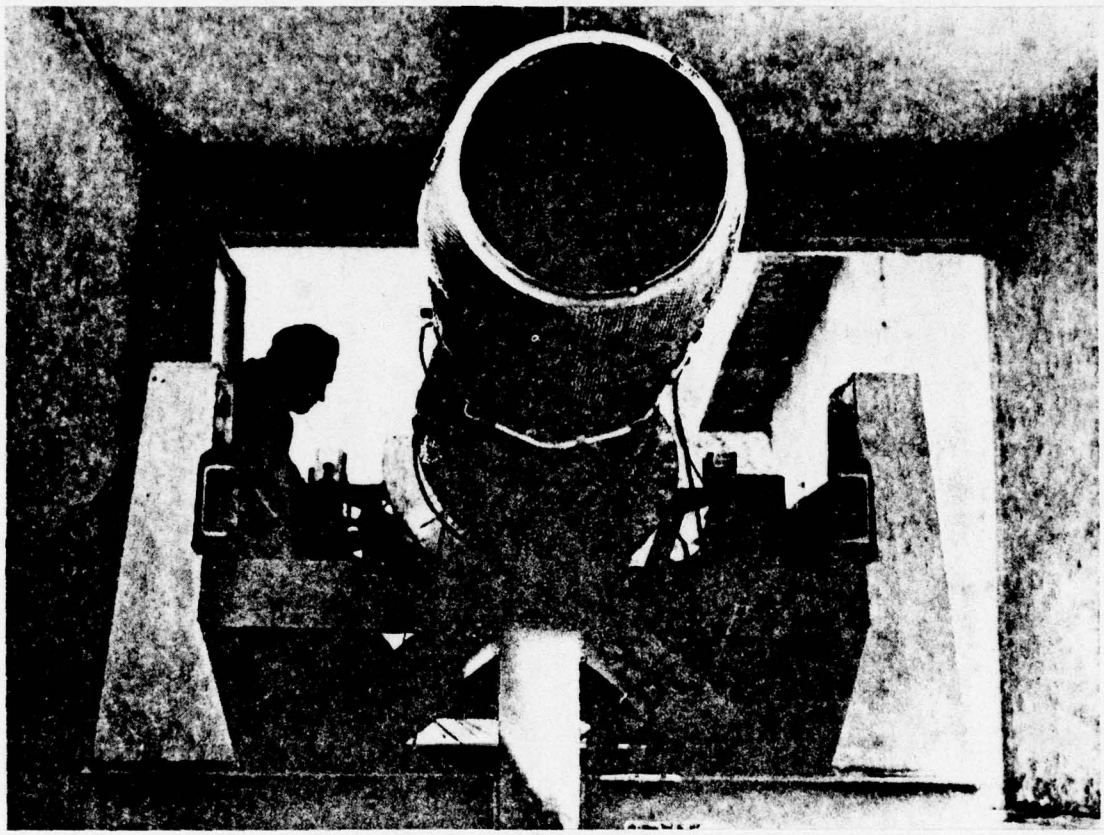


Photo Caption: Performance testing of jet engines

AIRPLANE AND FLYING DEVICES AND INSTRUMENTS

From the area of scientific research it includes:

- Studies, monitoring, and generation of information regarding contemporary technical state-of-the-art in the field of application of instruments, accessories, and devices.

- Selection of optimal accessories for the given purpose.
- Plans integration of instruments and develops technical conditions and instructions for instruments.

This activity disposes with a modern laboratory containing special devices for complete precision testing and calibration of instruments and accessories.

The testing can be carried out according to domestic or foreign specifications: JUS, VPE, ASTM, MIL, AER, and other recognized norms.

The laboratory disposes with the devices for testing accessories and materials, their mechanical durability at elevated and low temperatures, reduced pressure, acceleration, and vibrations.

The laboratory performs inspection of assembly-line products along with the issuance of related attestations.

LABORATORY DEVICES FOR MECHANICAL AND CLIMATIC TESTING AND THEIR CHARACTERISTICS

Bowser type L-18-100 VH climatic chamber

Serves for testing the devices and materials under various climatic conditions. Climatic testing of electric devices is possible when they are in operation. Testing is possible within the range of negative temperatures from $0^{o}C$ to $-60^{o}C$, relative humidity from 20% to 95%, and barometric pressures from 760 to 90 mm Hg.

The required climatic conditions (temperature, relative humidity, and barometric pressure) can be obtained simultaneously in the

climatic chamber.

Photo Caption: Barometric chamber for testing under various climatic conditions

The dimensions of the operating space of the chamber are as follows: 760 mm (width) x 760 mm (height) x 910 mm (depth).

Universal thermostat with thermal regulation

is used for testing the devices and materials exposed to positive temperatures. The testing is possible within the range of positive temperatures from +36°C to +80°C.

The accuracy of thermal regulation is ± 0.5°C.
The dimensions of the operating space are 600 x 800 x 500 mm.

Cylindrical dry thermostat with electric heating

is used for testing the devices and materials exposed to positive temperatures.

Testing is possible within the range of positive temperatures from +36°C to +105°C.

Dimensions of the operating space are 300 x 300 x 350 mm.

Small centrifuge

is used for testing small sensitive instruments and devices exposed to the effect of steady acceleration of various magnitudes up to a maximum of 20 G.

The effective diameter of the rotating disk envisaged for fastening the device being tested is 609 mm.

The device can be fastened as desired.
The maximal weight of the device which can be tested is 6.81 kg.

Large centrifuge

is used for testing of instruments and devices exposed to the effect of steady acceleration of various magnitudes up to a maximum of 35G.

Tested components up to 3 kg in weight can be exposed to acceleration up to a maximum of 35G, and the tested components up to 40 kg in weight to acceleration up to a maximum of 16 G.

The specific purpose of the centrifuge is in the calibration of the devices whose operation is based on the effect of acceleration, for example accelerometer, inertial relay, etc., and the testing of components affected by acceleration.

The air installation located in the assembly of the devices enables testing of instruments operating on an air subpressure or air passage, as well as under the effect of various accelerations.

The control of the behavior of individual devices tested can be effected by using an automated photo camera.

Photo Caption: Centrifuge for testing the instruments exposed to the acceleration effect

Bench for testing gyroscopic instruments

All the flight conditions peculiar to the testing of gyroscopic instruments can be simulated on the test bench.

The accuracy of the indication of instruments can be tested and calibrated in combined rolling, lifting, and turning maneuvers.

The following instruments can be tested on the bench:

- Turning and banking indicator,
- Artificial horizon,
- Directional gyro and similar gyroscopic instruments.

Bench for the testing of the manometer

is used for the testing of accuracy in indication and calibration of all kinds of manometers within the range from 0.2 to 300 kg/cm^2.

Device for testing of variometer (climb indicator) and altimeter (Fig. 4)(variometer = vertical speed indicator)

is used for testing the accuracy in indication and calibration of climb indicators and altimeters during climb and descent within the altitude range from 0 m to 30,000 m.

Device for testing the rpm instrument

is designed for testing the accuracy in indication and calibration of the indicators and generators of the electric rpm and airspeed indicator, and similar instruments.

Testing within range from 100 to 6000 rpm per minute is possible.

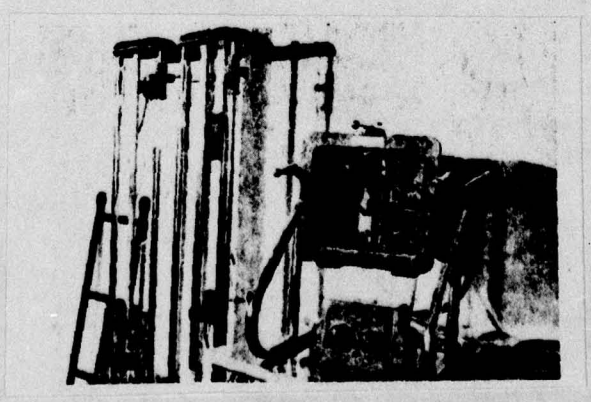


Photo Caption: Device for testing engine rpm instrument

Type ST-600 (electronic) vibration bench

is used for creation of mechanical oscillations similar to those found in practice. The amplitude frequency can be continually automatically changed within the range from 20 to 600 Hz, and hence the oscillations obtained can be observed. The testing of resonance conditions of instruments and devices subjected to oscillations is possible within the afore-mentioned frequency range.

Other technical data:

- Amplitude range ..... 0 to ± 8 mm
- Acceleration range in vacuum... 0 to 10G
- Acceleration range at 5-kg load ... 0 to 4G
- Experimental weight ..... max 5 kg
- Size of working bench ..... Ø 120 mm
  Ø 250 mm

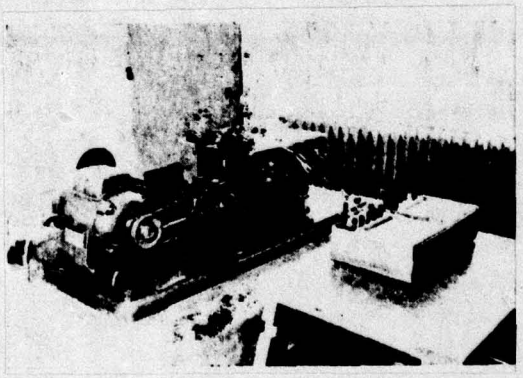


Photo Caption: Vibration bench

Type 100-HL-A (mechanical) vibration bench (Fig. 5)

is used for the creation of mechanical oscillations similar to those found in practice.

The amplitude frequency can be manually adjusted within the range from 10 to 60 Hz, and automatically in the range from 10 to 55 Hz. Automatic adjustment of amplitude is continuous. Within the afore-mentioned amplitude range the testing of resonance conditions of instruments and devices subjected to oscillations is possible.

Other technical data:

- Amplitude range 0 to 3 mm
- Acceleration range at 4.5 kg load 0 to 10G
- Size of working bench 370 x 440 mm

Brief overview of testing performed

- testing of air manometers (Rudi Čajevac in Banja Luka),
- altimeter testing (Teleoptik in Zemun),
- testing of pneumatic switches,
- testing of oil manometers,
- testing of quantity-meters (Teleoptik in Zemun),
- testing of electrical oil temperature gauge (Teleoptik in Zemun),
- testing of electric engine rpm indicator,
- testing of electric artificial horizon (Teleoptik in Zemun).

FUEL AND LUBRICANTS LABORATORY

The area of fuels and lubricants includes the treatment of the following problems:

- generation of complete reports on organization and equipment of lubrication service in production sections, with the selection of an assortment of products according to the available machinery; selection of fuel symbolism; work on specifications and nomenclature.

- Planning the devices for recycling of used lubricants.
- Selection of lubricants for new types of engines as well as various types of engines.
- Complete analysis of raw naphtha and its products (fuel, lubricants, etc.).

The fuels and lubricants laboratory performs a complete quality control, determination and testing of physical, chemical, and physicochemical characteristics.

The devices available to the laboratory enable testing according to the prescribed standard methods, i.e. JUS, ASTM, GOST, VV-L-791e, IP, DIN, etc. Nonstandard procedures for the appraisal of the quality of materials and the change in quality during use are elaborated.

The laboratory performs testing of the following materials:
- engine fuels and special fuels,
- lubricating oils,
- lubrication grease,
- hydraulic systems fluids,
- coolants,
- cleansing fluids,

- materials for the protection of metals and organic materials,
- materials for specific purposes (insulation, prevention of engine freeze, etc.).

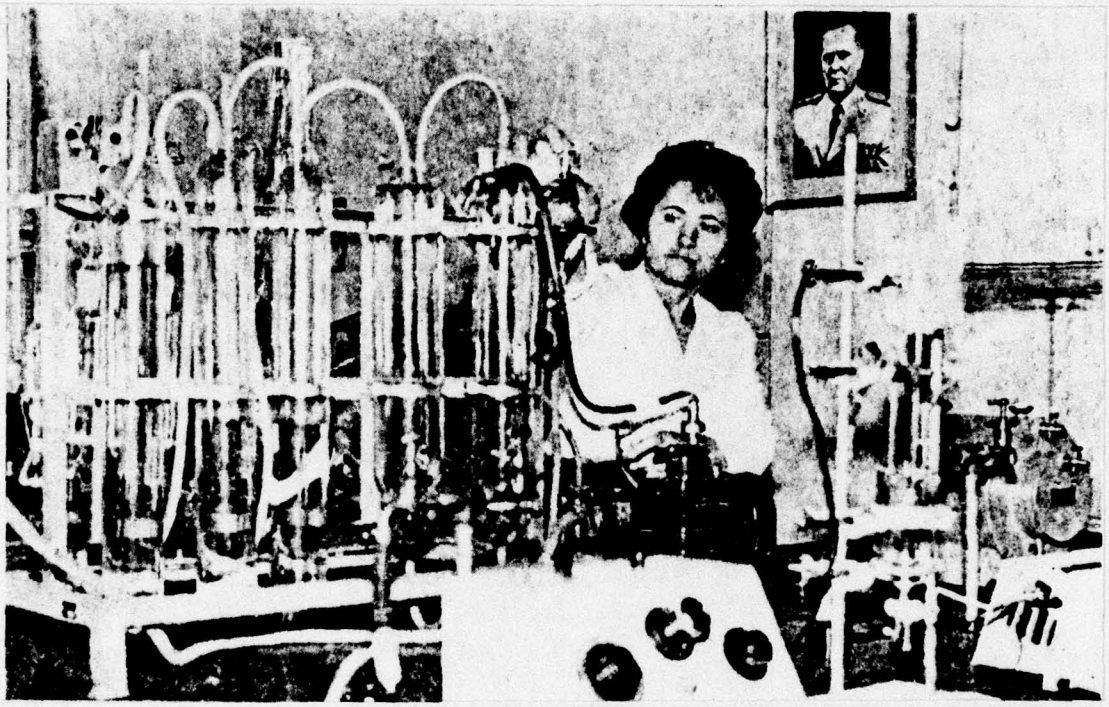


Photo Caption: Testing propulsion materials

Testing of engine fuels and special fuels

performs complete testing of all kinds of fuels according to any domestic or foreign specification, namely: JUS, MIL, E. Eng. R.D. GOST,TUV, etc.

The laboratory has available CFR engines for complete determination of octane fuels of engine and avgas according to research methods, engine methods, aviation methods, and by the rich

mixture method.

Fuel testing comprises quality determination of the following fuels:

- basic gasolines,
- engine gasoline,
- AVGAS,
- petroleum for engines, torpedos, and lighting,
- diesel fuels,
- jet engine fuels,
- heating oils,
- special gasolines.

In addition to testing the fuel quality, the Laboratory studies fuel selection and:

- selects the most suitable fuel for the given engine,
- develops conditions for fuels,
- cooperates with domestic manufacturers in marketing of new products,
- evaluates the sensitivity of the components and gasoline to the ethyl liquid,
- plots distillation diagrams and fuel mixture diagrams,
- determines the group composition of hydrocarbons in the fuel,
- performs elementary analysis of fuel also,
- studies the combustion processes and analyzes the combustion products,
- studies the effect of tar materials on sedimentation in engines,
- analyses carbon deposits off spark plugs, pistons, and carburetion systems.

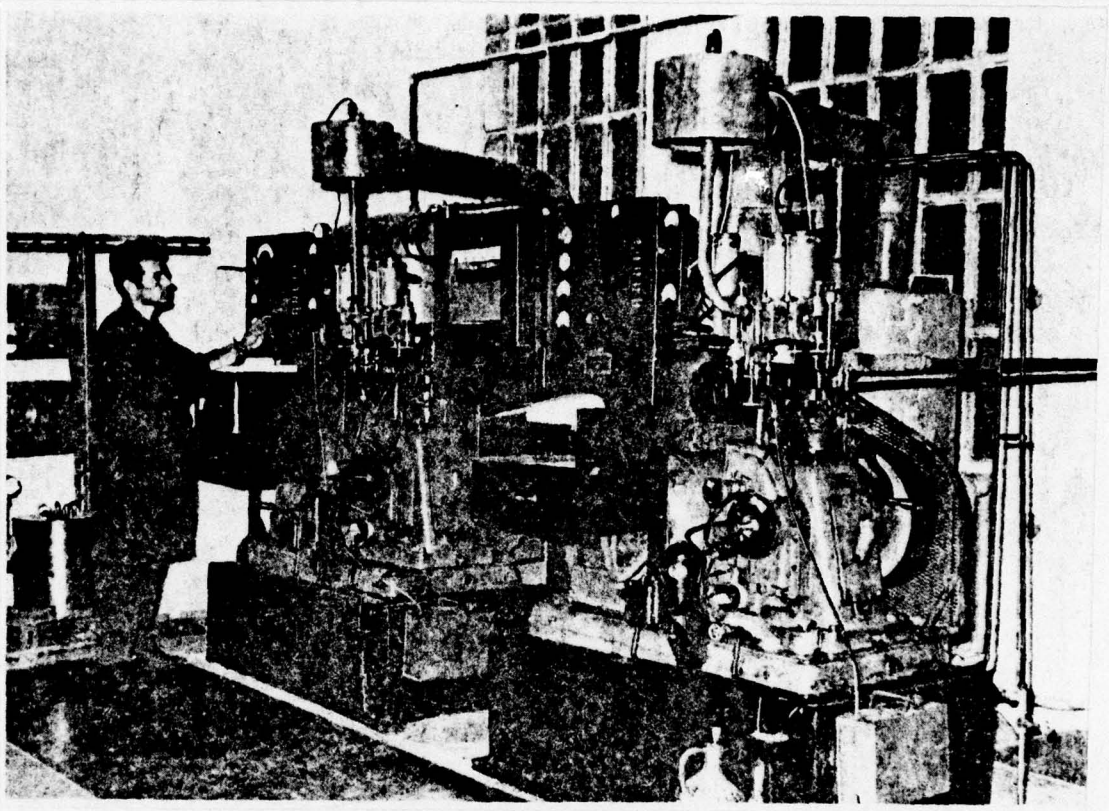


Photo Caption: CFR engines for testing octane fuels

TESTING OF LUBRICATING OILS

Performs complete testing and quality control of lubricating oils by determining the basic characteristics, such as:

- viscosity at all temperatures, even below $0^{o}C$,
- viscosity index,
- firing temperature,
- temperature of opalescence (muddiness) and densification (hardening),

- corrosion on the Cu-plate,
- water and impurities content
- neutralization number,
- dissolved acids bases in water,
- ash and coke content,
- "UNION" number.

Quality control is done in case of the following lubricating oils:

- engine oils,
- aircraft engine oils,
- aircraft turbine oils,
- hypoid oils,
- high-pressure oils,
- automatic transmission fluids,
- turbine oils,
- compressor oils,
- cooling compressor oils,
- spindle oils,
- bearing oils,
- circulation oils,
- cylinder oils for saturated and overheated steam,
- vaseline oils,
- bone oils,
- special purpose oils, such as aircraft turbine synthetic oils, synthetic oils for low temperatures, synthetic oils for high temperatures, and so on.

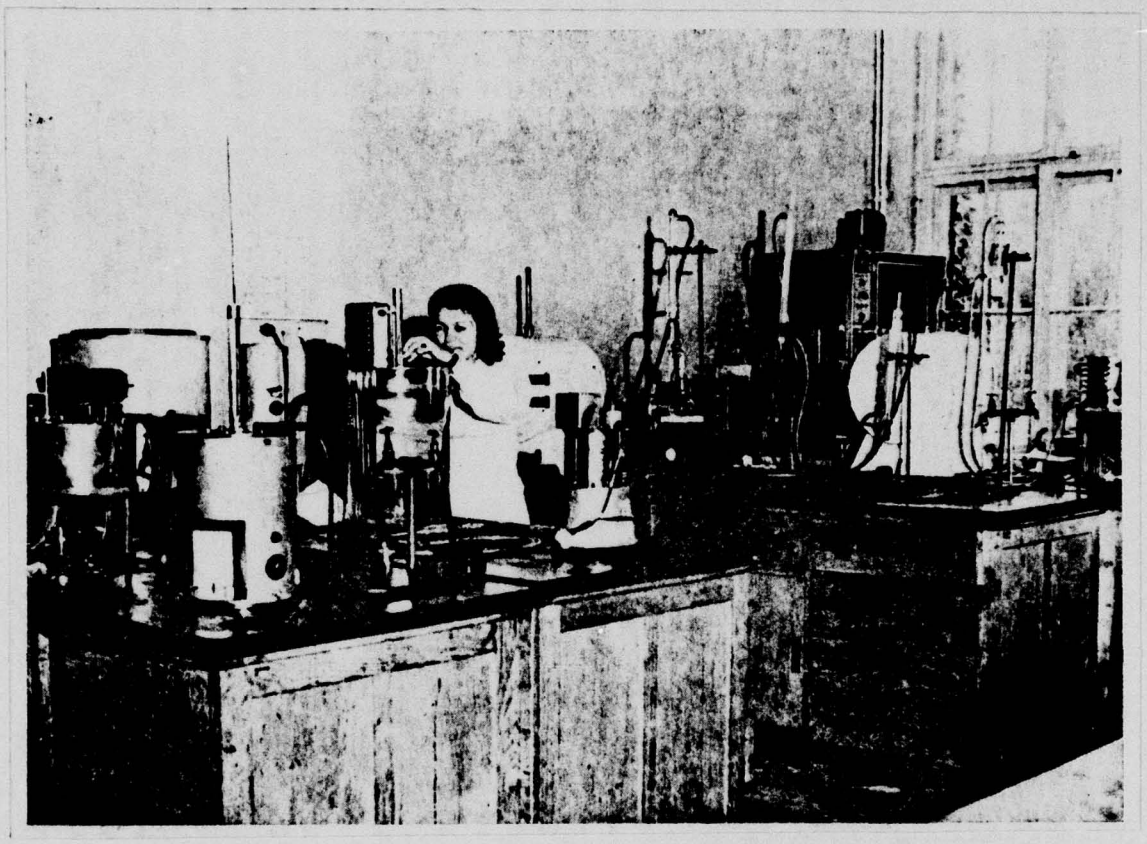


Photo Caption: Oil testing

TESTING OF HYDRAULIC SYSTEM FLUIDS

Performs complete testing of all conditioned physicochemical characteristics essential for the quality appraisal of hydraulic fluids.

Elaborates programs for practical testing and methods of monitoring the changes occurring in hydraulic fluid during operation.

Determines the reclamation periods.

Determines the storage times, and after detailed testing issues permits for the extension of the same along with the determination of periods of quality control.

Approves hydraulic fluids for the Air Force after determining oxidation resistance, corrosion aggressiveness, viscosity stability, low-temperature characteristics, and aggressiveness on sealing materials (gaskets, seals).

Offers professional assistance in determining the sealing material for hydraulic systems depending on the applied hydraulic fluid.

TESTING OF LUBRICATING GREASE

Performs determination of a series of characteristics conditioned for the appraisal of the quality of lubricating grease as follows:

- composition of grease, kind and quantity of oil, soap, and fillers
- dripping and melting temperatures
- penetration, operating penetration, and mechanical stability after compression
- water content and that of mechanical impurities
- ash content
- grease loss at elevated temperatures
- oxidation stability
- corrosion attack
- resistance to water (rinsing)
- grease loss during vaporization
- resistance of grease film (welding of balls in a 4-ball set)
- useability at low temperatures

- storage stability
- neutralization number
- free alkali and free fatty acid contents
- colloidal stability

In the area of lubricating greases the laboratory is engaged in solving the following problems:

- performs quality control of lubricating greases
- selects and recommends for use the most suitable greases
- selects substitutes, and depending on location of use immediately determines the substitutes, or approves replaceability after a practical check.
- offers professional aid in solving application problems
- tests the E.P. properties of lubricating greases
- determines storage periods

TESTING THE COOLANTS, CLEANSING FLUIDS, PROTECTION AGENTS AND OTHER COMPOUNDS FOR SPECIAL PURPOSES

Performs testing and checks the quality of various materials for their maintenance, such as:

- antifreeze
- metal treatment oils
- cleansing and greasing agents
- oils, solvents, and greases for metal protection
- engine conservation oils
- agents for the protection of organic materials (leather, rubber, wood)
- insulation oils and greases
- vaselines and vaseline oils

- plant and animal oils
- additives
- ethyl fuels for testing
- agents for freezing prevention
- special purpose agents (compass fluids, anti-icing fluids, glycerin, etc.)

The apparatus available to the laboratory enables quality control and extended testing with the purpose of solving the following problems:

- selection of the most favorite maintenance agent
- selection of substitute and determination of substitution
- testing of efficacy of the agents depending on the location and conditions of application, etc.

A BRIEF OVERVIEW OF TESTS PERFORMED

Complete quality control of principal propulsion agents in civil aviation for the needs of the following enterprises:

- Civil aviation administration
- JAT (Yugoslav Air Transport)
- INA - Zagreb and all their aeroservices in the country
- Jugopetrol - Belgrade and all its aeroservices
- Aeronautical Association of Serbia and aeronautical centers in Vršac and Osijek.

Complete quality control of all propulsion and maintenance agents in the JNA .

Complete quality control of all aeronautical agents and development of conditions for aeronautical fuels and lubricants.

Quality control of various materials according to specific requirements is performed for the following:

- Federal market inspector's office
- Jugoinspekt
- Piram -- Kikinda
- Antikor -- Belgrade
- Jugopetrol -- Belgrade
- Oil refinery - Bosanski Brod and Modrič operation
- Idol - Novi Sad
- Motor Review and AMS - Yugoslavia (AMS = Auto-moto Savez = = Automobile Association)

Quality testing is done for the following materials:

- basic AVGAS (Sisak)
- AVGAS from the catalytic cracking (Sisak)
- aircraft engine oil (Rijeka)
- Hydraulic oil 377 (ENOL)
- hydraulic oil OHA for aircraft hydro-devices (ENOL)
- engine oil (ANTIKOR)

Homologation testing performed on the following materials:

- B-67 and B-100/130 fuel mixture of eastern and western origin on the test bench and in the airplanes during which testing of carbon deposits and changes occurred in oil are carried out
- useability of AVGAS with increased contents of resin materials for Interpetrol
- aircraft 1120 engine oil of domestic production on the test

bench and in the airplane during which laboratory monitoring of the changes occurred in oil is performed (Rijeka)

- W-100 aviation oil produced by Shell in the aircraft and laboratory testing of the changes occurred in the oil

- Aero Shell Grease 17 containing molybdenum disulfide.

The following substitutes are determined for:

- Caltex 207 oil
- agents for propulsion and maintenance of helicopters
- OM-3 brand name oil
- foreign cleansing agents DTD 445, P-S-661, and TT-N-95
- ciatim 201
- Mil-G-7711A grease
- GOST 4003-53 oil
- GOST 5546-56 oil
- ciatim grease 221 and various other materials.

Testing of additive deterioration (Railroad Institute, Belgrade).

Testing of detergency and monitoring of deterioration of detergents during the operation of the engine (Railroad Institute, Belgrade).

Testing the used oils with the purpose of finding the causes of engine freezing (Motorski Institut - Komodraž).

Oil selection for engine lubrication on hydrofoil ships of the "Raketa" type (JRB Belgrade).

Testing of electrical insulation oils and the effect of drying on the increase of the electric penetration strength (Elektro-

istok, Jugopetrol, etc.).

Testing the possibility of application of natural gas (Elemir).
Testing the possibility of obtaining MB-80 engine gasoline from MB-74 by mixing with ethylized platforming.
Testing the possibility of obtaining fluids to determine in the TKS aircraft system and generation of acceptance specifications.

Determination and testing of oil mixtures for lubrication of turboprop engines.

Testing the effect of low-temperature components on the decrease of opalescence (turbidity) and densification in case of domestic diesel fuels.

In addition to work associated with the realization of the afore-mentioned operations the laboratory experts for fuels and lubricants monitor the latest state-of-the-art from the field of propulsion materials, develop and improve the testing methods and carry out the revision of methods in harmony with the conditioned testing methods (JUS, ASTM, DIN, GOST, etc.).

Monitor and update the latest conditions for propulsion materials and develop the conditions for aeronautical-propulsion materials. Perform translations of the conditions, methods, and technical instructions from foreign languages. Take part in the development and issuance of JUS norms.

Carry out the training of refinery inspectors and provide the professional practice to the experts of the enterprises involved with the problems and testing of propulsion materials. So far the following experts have been in the professional practice, coming from: Motorski Institute, Kumodraž; "21 maja", Rakovica; Železnicki Institut (Railroad Institute), Belgrade; Jugopetrol, Čukarica; and Jugopetrol, Surčin.

The laboratory experts cooperate with all domestic manufacturers relative to the problems associated with laboratory testing and quality checking during use.

The laboratory is in the position to solve additional multi-varied problems from the field of testing and application of propulsion materials.

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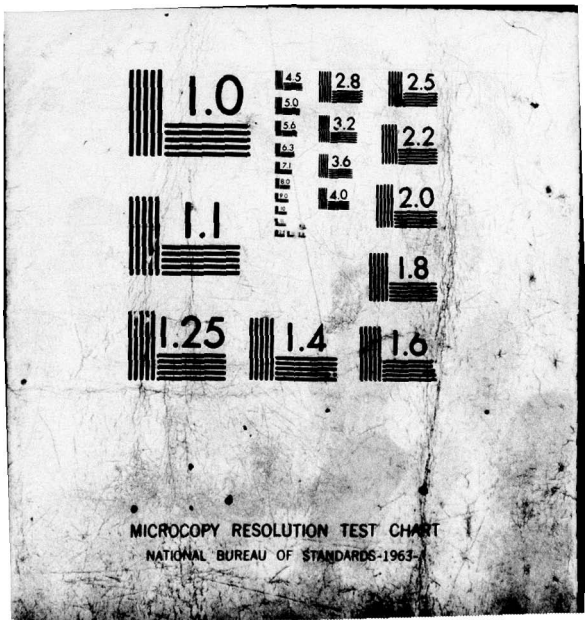
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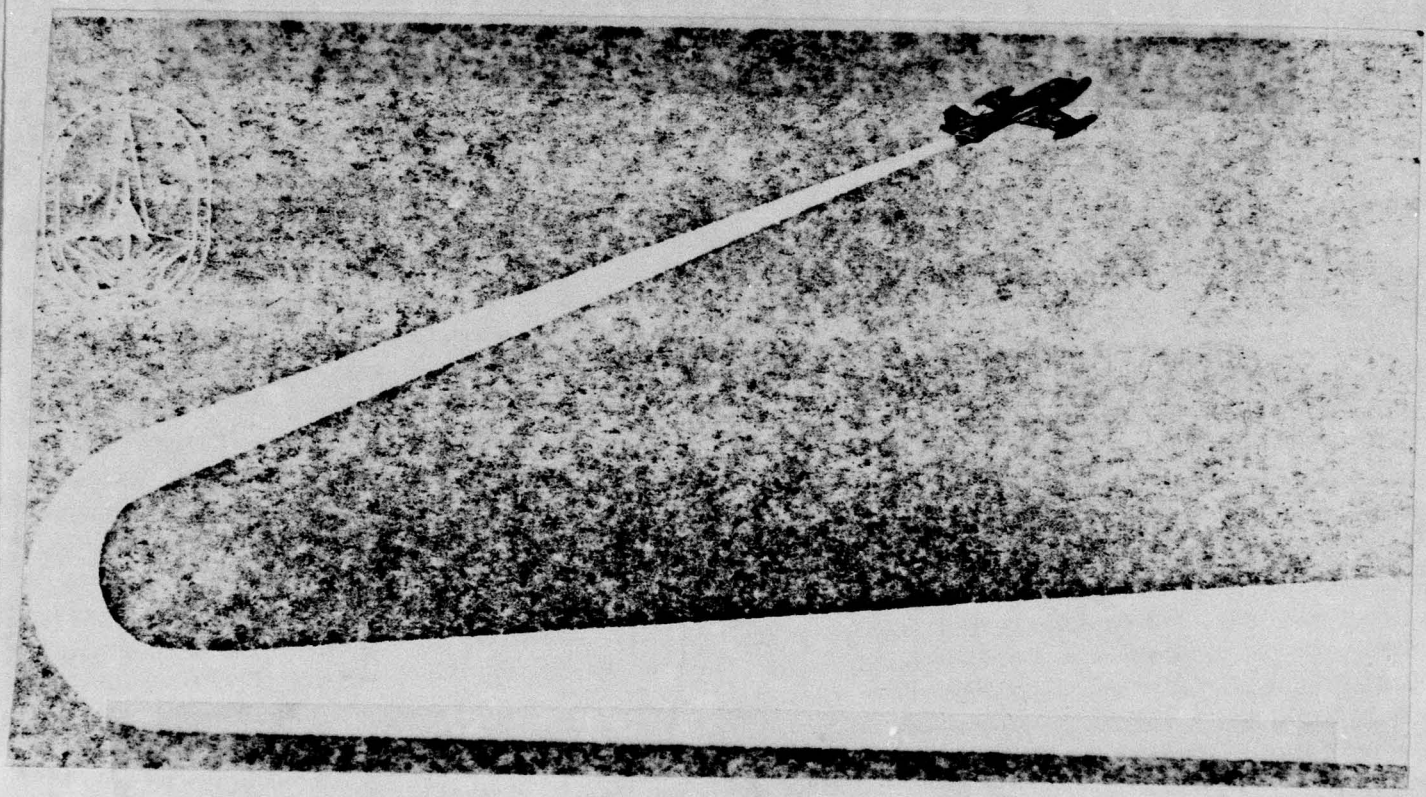
THE INSTITUTE OF AERONAUTICS

Belgrade - Zardovo



The Institute of Aeronautics (VTI) is a scientific-research institution, founded in 1946. The VTI is equipped to carry out the scientific-research, planning, technical, documentation-information, and manufacturing services in the area of aeronautics, as well as in other areas of technology. It possesses a large number of laboratories and testing installations equipped with the most advanced devices, as well as a scientific-professional library and data bank.

A large number of aeronautical engineers, as well as engineers, technicians, and highly skilled workers of different fields of specialization is engaged in the operations of the scientific-research and planning activities.

The VTI formulates the following: regulations on technical measures, standards, and specifications.

It carries out the following: the product quality control, and issuance of attestations and certificates, homologation of aircraft, component parts, sub-assemblies, assemblies of finished products, devices and machinery for the workshop services (metalworking, milling machine, gringing, sheet metal, carpentry, and model shop).

It takes on the following operations: engineering tasks from the area of planning and design (shell-, latticed-, and other metal construction, hydro- and pneumatic installations, as well as installations for amortization and braking).

It carries out the following tests and measurements:

testing all kinds of models of aircraft and projects from other branches of technology (automobiles, ships, trains, fans, construction projects) in the aerodynamic wind tunnels, under the effect of air currents of both high and low velocities.

It tests and measures, electronically, static deformations, torsional oscillations, sound processes, short time intervals, acceleration, pressures, dynamic vibrations, fluid flow, forces and thrusts, temperature, dislocations, and other mechanical and physical values.

Carries out all mechanical and climatic tests of the equipment and materials for all temperatures, according to the world established standards.

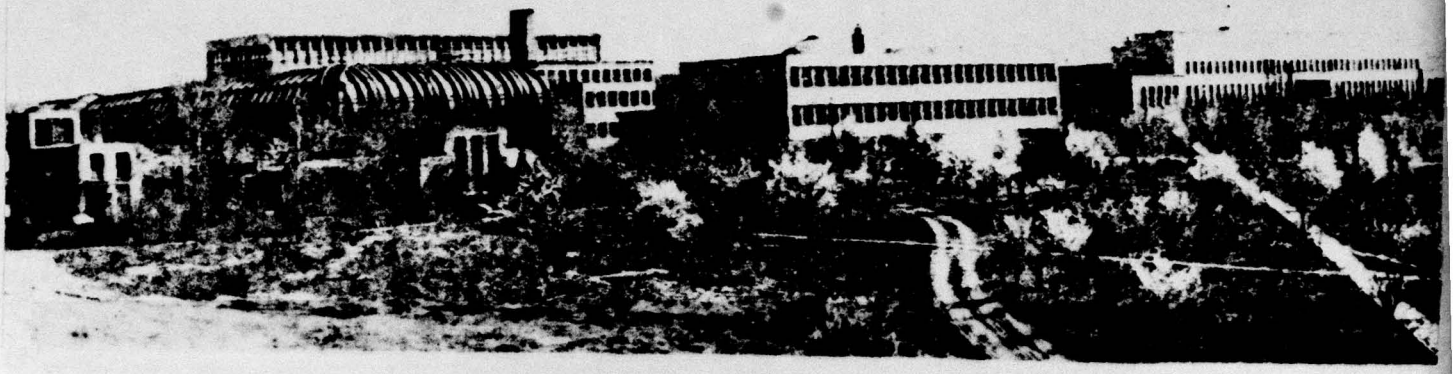
Tests the mechanical-technological characteristics of all kinds of metal and non-metals, design elements, and finished products. Performs analyses and determines the properties of all kinds of fuels in its fuel and lubricant laboratory.

The VTI is a registered and certified institution to perform all the tests and attestations currently done in its laboratories, and is also an authorized organ of the Yugoslav Registry (Lloyd), whose test results are recognized by the foreign institutions.

During all its existence, the VTI has fully harnessed material production and has developed a cooperation with a large number of economic organizations. The scientific-research projects are performed in cooperation with the economy - for both military

and civilian needs.

So far, the VTI has published a large number of scientific-research papers in the form of notices, reports, and technical-economic analyses. However, by far the greatest achievements are the airplane designs, "Galeb," "Jastreb," and "Kraguj," which obtained high international recognition. Likewise, the Institute built its own laboratories with its own resources, among which the large aerodynamic wind tunnel and the workroom for static and dynamic tests are particularly distinguished.



The scientific-research work in the area of aerodynamics is distinguished by a great diversification. Tests are performed by both theoretical-analytical and experimental methods. Numerous advanced research and experimental installations and devices were built for testing various kinds of models and projects. Experimental tests of aerodynamic phenomena are performed in the aerodynamic wind tunnels which are then recorded on the most advanced electronic instruments.

THE T-31 AERODYNAMIC WIND TUNNEL WITH THE FREE JET STREAMS

The highest velocity of the air current is 40 meters per second. The operating part of the circular diameter is 2.5 meters, with free jet stream.

This wind tunnel is suitable for the kind of testing by which certain parts or products of the processes (gases, toxins, etc.) are ejected from the elements, as well as observations and measurements of the deformation of elements to the point of destruction. Filling in with sand, rain, snowdrift, and the defense against these elements, can be studied and analyzed.

THE SMALL-SIZED SUBSONIC T-32 WIND TUNNEL

The highest velocity of the air current is 72 meters per second. The operating part is elliptical, 1.8 x 2 meters, semi-open, 2 meters long.

In addition to the strictly aerodynamic tests, for which this wind tunnel is basically equipped, it is possible to perform

a whole series of tests of the non-aeronautical character without any, or with very small adaptations. As, for example, testing the rail- and road vehicles to improve streamlining, thus to reduce air resistence.

It is possible to test the models of bridges, TV towers, long-distance power lines, etc., both for streamlining against the relative wind, and for vibrations and deformations. Visualizations are possible of the air resistence of buildings, smokestacks, and ships; recordings of air circulation, measurements of the fields of velocities and pressures to maintain local loads on structures.

WATER-CAVITAION T-33 WIND TUNNEL

The highest velocity of the water flow is 11 meters per second. The operating part is shut, is 0.50 meters wide, 0.35 high, and 0.50 meters long.

This wind tunnel makes possible observations and analyses of the cavitation phenomena on models and ships' propellers; studies of the shape resistence for underwater parts of ships or towing elements; speedometer calibrations for water flows of smaller dimensions.

LARGE SUBSONIC T-35 WIND TUNNEL

The highest achieved velocity of the air current is 180 meters per second. The operating part is shut, 4.4 meters wide, 3.2 meters high, and 4.0 meters long.

Where the small-sized subsonic T-32 wind tunnel would not be satisfactory, either due to the limited dimensions of the operating part, or the relatively low maximal velocity, the large subsonic T-35 wind tunnel can successfully solve the problems.

Thanks to the possibility of opening the large joint, thus converting the wind tunnel into the open-type tunnel, it is possible to obtain, at the outlet of the diffusor, a fairly uniform air current of approximately 30 m/s (110 kilometers per hour) at the cross-section of the elliptical shape, 12 x 9 meters, where it is possible to test the objects in their natural performance and under the conditions identical to hurricane winds.

TRANSONIC-SUPERSONIC T-36 WIND TUNNEL

The highest achieved velocity is 3.24 Mach. The operating part is square, 0.25 x 0.25 meters, and 0.6 meters long.

By its purpose, the wind tunnel is destined exclusively for studying aeronautical problems associated with high velocities.

However, the accessory installations of this wind tunnel, such as the batteries of the vacuum pumps, and the vacuum tank, offer wide possibilities for utilization in the form of versatile application of the vacuum. Such as, the behavior of the tank or pipeline under external pressures, as well as the behavior ov various devices and instruments in rarefied air, or the possibility of biological tests linked to the

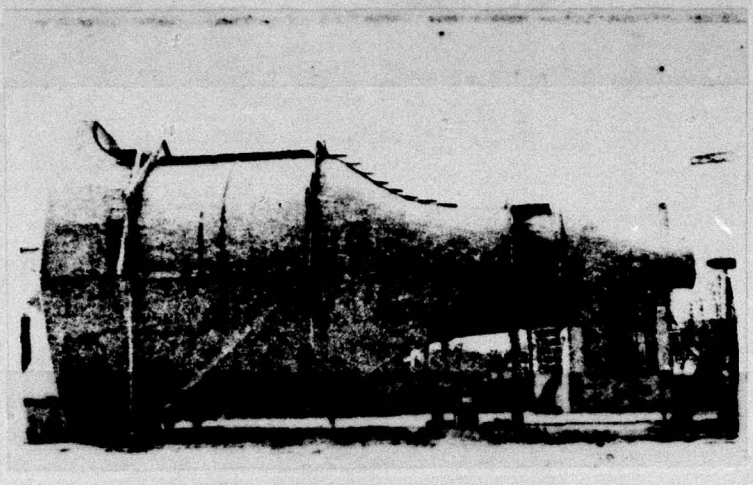
existence of vacuum.

AEROTHERMODYNAMIC LABORATORY

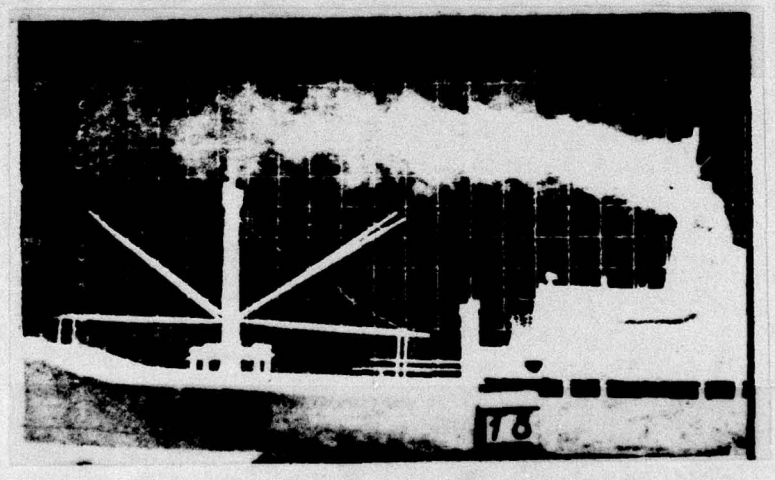
In this laboratory, a furnace was built intended for testing the refractory partition plates, size 2.2 x 2.5 meters.

It is possible, during combustion, to program the time intensity of the temperatures ranging from 20 - 1200° Celsius. The temperature is measured by electronic instruments and is recorded on a measuring tape.

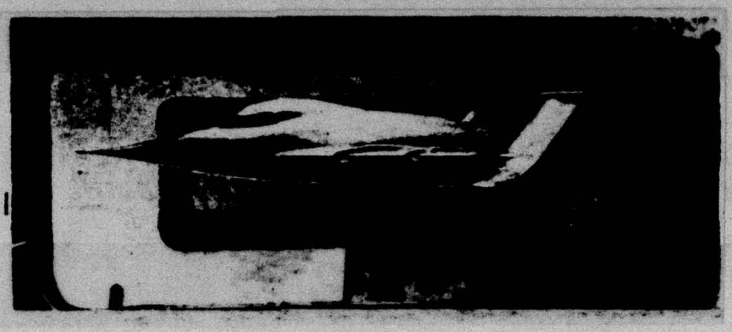
The tests and attestations of the partition walls made of refractory plates intended for the shipbuilding industry, are recognized by the Lloyd, Yugoslav Registry, the USSR Registry, and the Sudoimport of the USSR.



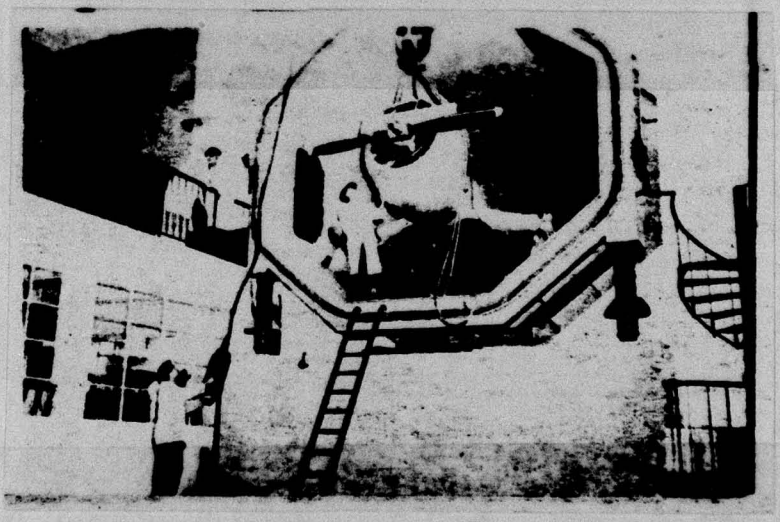
Aero wind tunnel with the added T-31 collector



Testing a ship's smokestack in the small subsonic T-32 wind tunnel



A model airplane in the water-cavitation T-33 tunnel



Preparations for testing a propeller-driven airplane in the large aubsonic T-35 wind tunnel

"Cvrstoca" is involved in all the theoretical and experimental problems of the strength of materials in the area of the scientific and applied research and development. This activity includes the studies and regulating the requirements, conditions and rules, development and application of the research methods, deriving proofs from the entire area of the structural strength and systems of various structures, and the issuance of technical documents on their strength. A static workroom was built to carry out experimental research and tests, equipped with the most advanced specialized installations for both static and dynamic testing.

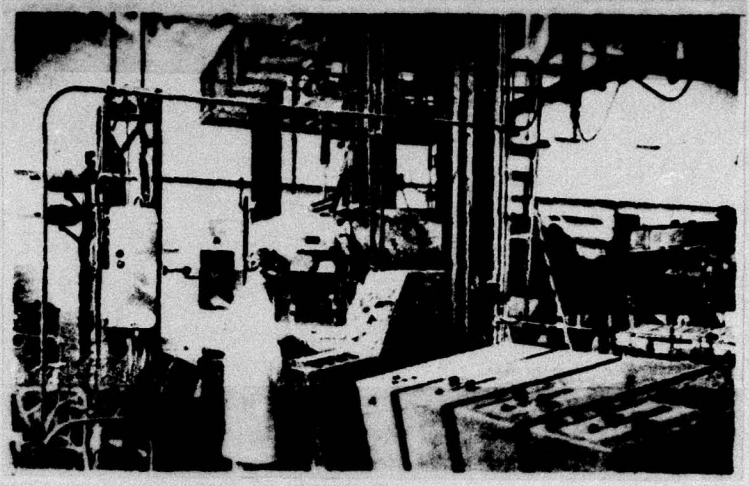
For theoretical calculations, as well as various experimental data, the "Cvrstoca" utilizes a modern digital electronic computer, S II 10070, of the third generation.

The completeness of the strength tests is supplemented by several laboratories where applied research are carried out.

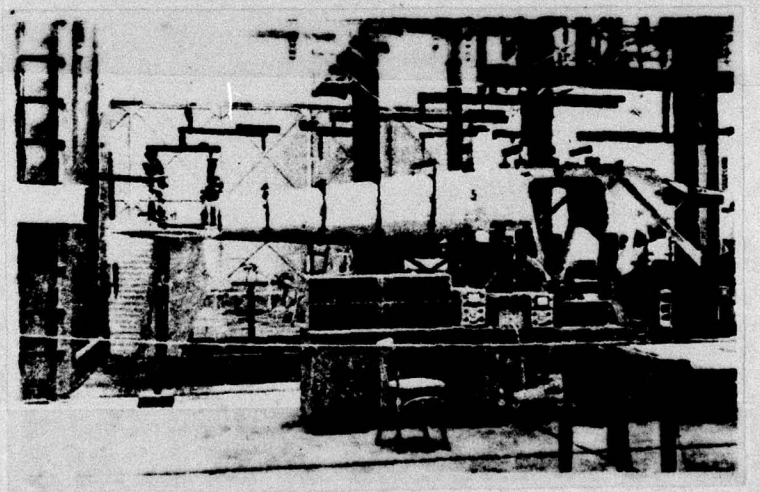
The laboratory for testing materials possesses modern installations and instruments and performs quality control, determines reliability and replaceability, issues attestations, carries out the defect (X-Ray, ultrasound), metallographic, mechanical (static, dynamic), chemical, and other tests of all kinds of metals and non-metals.

The laboratory for electronic measurements of mechanical magnitudes by electric and electronic means, replaces the existing classical measuring methods with the modern electronic

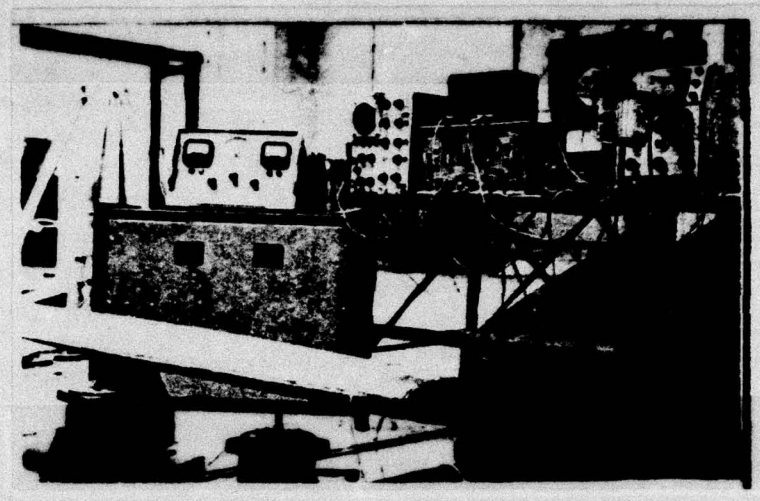
methods. The laboratory carries out studies, develops the methods, and analyzes the measurement results; solves complex tasks in the area of measuring non-electric values by electric and electronic means, such as: static, dynamic, and relative deformations and stresses at a large number of measuring points, simultaneously recording on several channels; vibrational characteristics and durability of structures and systems, measuring and frequency analysis of acoustic magnitudes, measurements of the procedures, pressures, temperature, flows, revolutions per minute (RPM), and others.



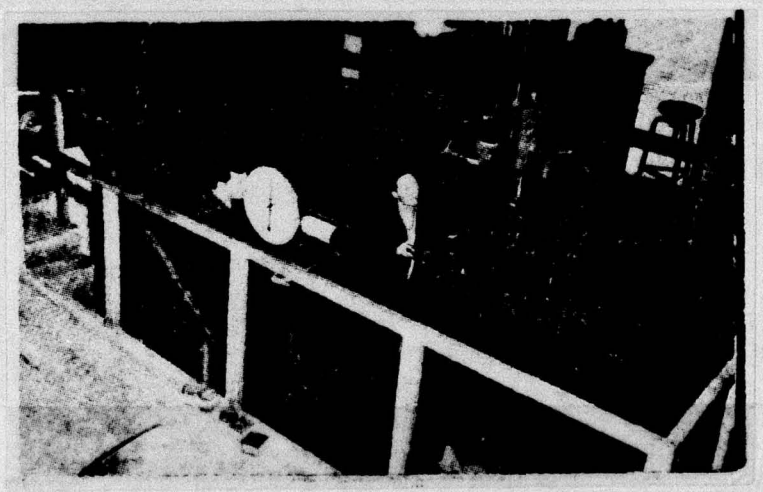
Control desk of the hydraulic installation during tests of the airplane fuselage, in the static workroom



Testing the strength of an airplane fuselage



Testing the frequency of a fan blade



Static testing of a rubber shock absorber on a 30 tone press

The activity of the facility encompasses studies, the issuance of requirements, conditions and regulations, development and research, planning and the fabrication of prototypes of the aeronautical equipment together with the armament, and tests on special installations to check the quality, homologation, issuing the attestations, as well as making selection.

The equipment facility has the following services:
- electric and electronic dealing with the application of the electric and electronic technology; possesses the analog electronic computers for solving mathematical models (solving the linear and non-linear differential equations, and simulation of the physical model by means of mathematical models).

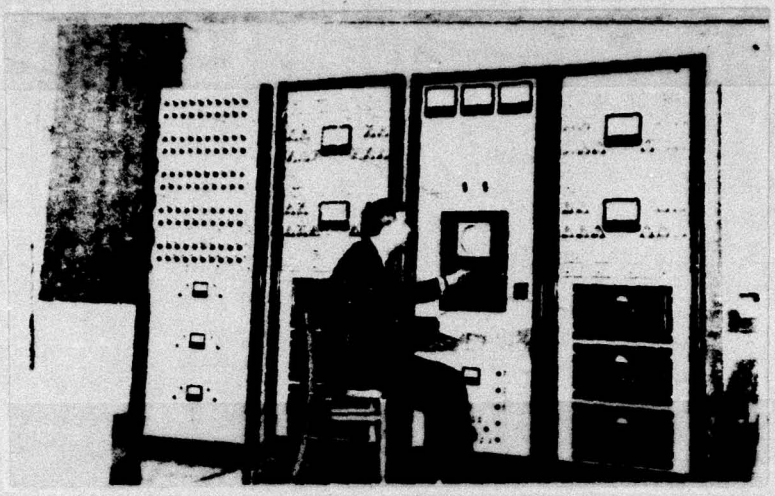
- motor service dealing with the studies, aerothermodynamic calculations of working cycles of all kinds of internal combustion engines (piston, turbine, rocket), researches and selects optimal solutions - vibrations of the engine elements and the whole engine, noise attenuation, heat exchange, durability of materials of various parts of engine, the characteristics of fuels, and their effect on the operation and durability of the engine.

- airplane and flying devices and instruments; studies, monitors, and the selection of optimal equipment for the given application; possesses a modern laboratory with specialized devices for a complete testing and calibration of instruments and equipment under various climatic conditions and the effect of acceleration,

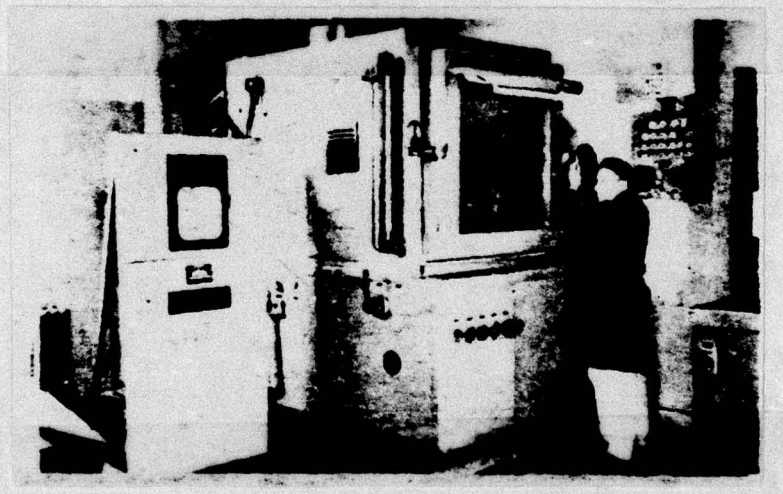
testing gyroscopic instruments, manometers, variometers and altitude indicators, engine RPM indicators; vibrational testing of instruments.

- The fuel and lubricant laboratory writes complete instructions on the organization and equipment of the lubrication service in the production plants, determines the assortment, selection of fuels and lubricants, works on their specification and nomenclature; performs complete analyses of raw naphtha and its products (fuel and lubricants), and others; performs a complete quality control (determines and tests the physical, chemical, and physical-chemical characteristics), according to the prescribed standard methods such as, JUS, ASTM, GOST, VV-L-791-e, IP, DIN, and others.

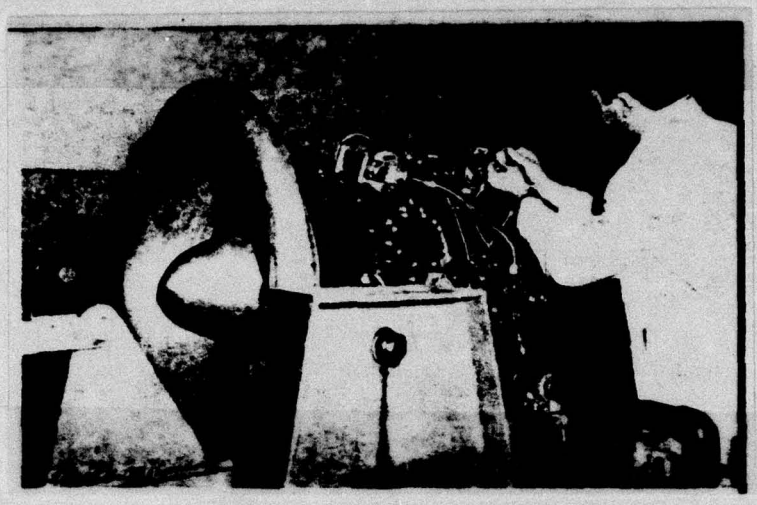
In addition, the laboratory tests the following materials: engine fuels and specialized fuels, lubricating oils, grease, hydraulic system liquids, coolants, cleansing liquids, the compounds for the protection of metals and organic materials, items for special applications (isolation, prevention of freezing, icing, and others).



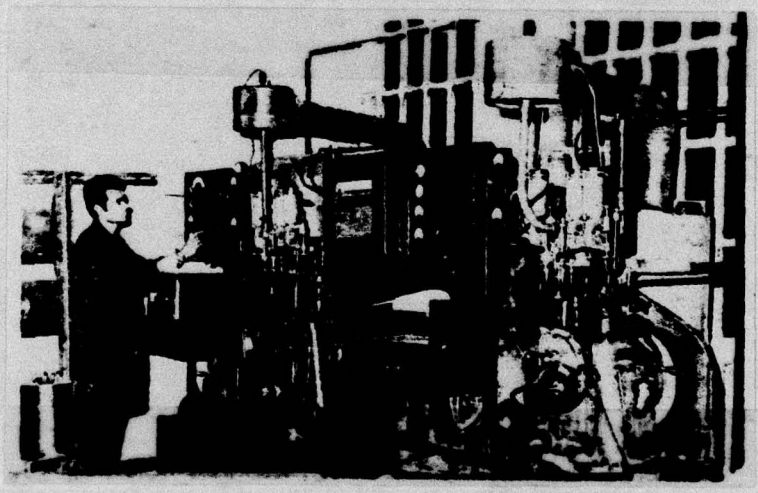
The analog electronic computer



Barometric chamber for testing under various climatic conditions



Preparations for testing a jet engine in a test station



CFR - engines by the methods F-2 and F-3 for a complete testing of octane fuels

The area of planning and design, in its current work, has achieved a full affirmation, offering in the area of metal designs and projects a complete engineering service, from general studies and research activity, planning and design, up to putting the installations, devices, and equipment into test operations.

The planning-design activity of the VTI, so far, has had a series of significant achievements. Through their projects, calculations, workshop and other technical documentation, the airplane design projects such as "Galeb," "Jastreb," and "Kraguj," have been materialized.

The VTI has a separately organized service for the scientific-technical documentation and information, whose jurisdiction is collecting information from various sources (domestic and foreign), and providing information of the technical character to the users. The collection of documents (books, periodical publications, regulations, standards, data banks, journals, and pamphlets) of both domestic and foreign sources, contain much information which can also benefit the experts of the non-aeronautical branches of technology, i.e. to the scientific workers, which can be obtained either nonprocessed (as copies), or as assorted and processed according to the party's requirements, which can also be of a lasting character (by subscription).

To provide various kinds of copies and photos in connection with research and tests, this service is equipped with the necessary technology which makes possible rendering usual reprographic (copying) services (on XEROX, Gestetner, and thermocopying), bookbinding and photo services (black and white, color, highspeed filming).

The experimental workshop is equipped with modern and precise machinery, devices, and tools for processing materials made of metal, wood, and plastics (Araldite); it is specialized for the tool production. Machine shop is equipped with lathes (both small and large), copying devices by means of models, universal milling machines, a pantograph machine.

In addition to the above, the tinsmith-locksmith, carpenter, and welding services can satisfy strong requirements customary in the aeronautical field, required from this kind of activity.

So far, these services, whose work was checked, confirm a high specialization and and class of workers, and the quality in this kind of production activity.

Photo Caption: Design

Photo Caption: The scientific-technical documentation and information

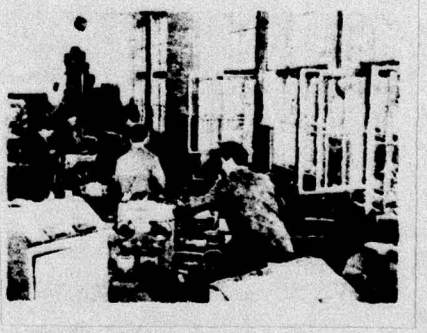


Photo Caption: The workshop services

Taken from inside of wind tunnel, showing a 12 blade fan mounted on its hub

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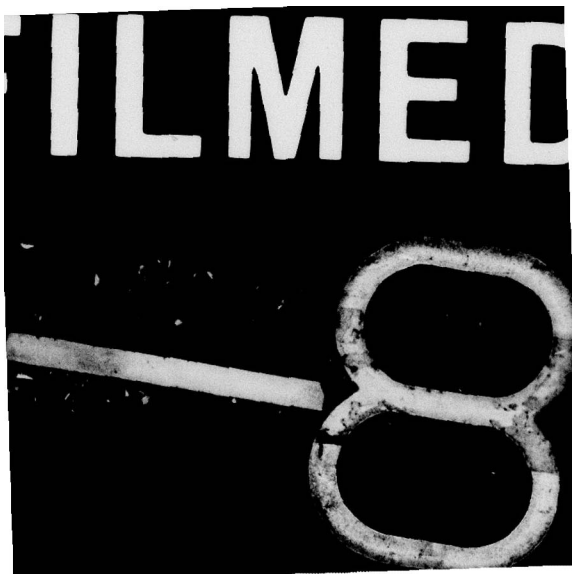
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